THE HUFFORD STRETCH-WRAP FORMING MACHINE

solves the problem of quick, accurate uniform production of complex shapes from sheets or extrusions

Production runs can be short or long with full economy and duplicate parts are easily re-run at any subsequent date.

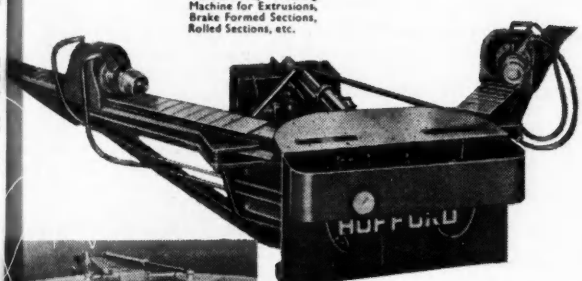
THE HUFFORD STRETCH-WRAP FORMING PRINCIPLE IN 3 QUICK STEPS

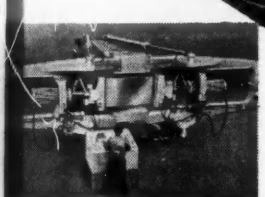
STRETCHED in front of a stationary die, metal becomes semi-plastic.

WRAPPED around die, plasticity aids in moulding metal to die contours.

FORMED at end of wrapping stroke, a final stretch permanently "sets" the shape.

Stretch-Wrap Forming Machine for Extrusions, Brake Formed Sections, Rolled Sections, etc.





Stretch-Wrap Forming Machine for sheet metal work.

Due to the stretching process, metal strength is actually improved. Hufford Stretch-Wrap Forming can be applied to aluminium and many of its alloys, various steels, including stainless, magnesium, etc. The machines, available in stretching capacities from 12 to 350 tons, accurately form both structural parts and sheets for the construction of frame elements and skin surfaces.

Unusual tooling ease is one feature of the Hufford Stretch-Wrap Forming Process. Simple dies, made from easily worked materials are suitable for contouring extrusions and narrow sheets. Steel facing ensures long runs. Dies cast from plaster moulds are most frequently used when forming large sheets.

Now accepted as the world-wide standard of the aircraft industry, Hufford Stretch-Wrap Forming machines are making a valuable contribution to increased productivity in the metal forming industries. If you want to know more about Hufford Stretch-Wrap Forming write to the Wickman Technical Publications Dept., for further details.

WICKMAN LIMITED

FACTORED MACHINE TOOL DIVISION, FLETCHAMSTEAD HIGHWAY, COVENTRY
Telephone: Coventry 60351

265.F.50

THE ENGINEER

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NOTICE TO READERS

All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC APPOINTMENTS

CARMARTHENSHIRE EDUCATION COMMITTEE

AMMANFORD TECHNICAL COLLEGE

ASSISTANT MASTER IN MECHANICAL ENGINEERING

Applications are invited for the post of full-time ASSISTANT MASTER IN MECHANICAL ENGINEERING.

Candidates should be Graduates or hold equivalent qualifications in Mechanical Engineering. Teaching and industrial experience would be an advantage.

Teaching duties will include classes in the Secondary Technical School and part-time day and evening Technical College Classes.

Duties to commence as soon as possible.

Salary in accordance with the Burnham Technical Scale for Grade A Assistants, with possible advancement to Grade B. Increments will be granted for approved teaching and/or industrial experience.

Application forms, which must be returned within two weeks of the appearance of this advertisement, may be obtained from the undersigned on receipt of a stamped, addressed foolscap envelope.

IORWERTH HOWELLS,
Director of Education.

Education Department,
County Hall,
Carmarthen. E5816

SOUTH SHIELDS EDUCATION AUTHORITY

MARINE AND TECHNICAL COLLEGE

Principal : J. HARGREAVES, M.A., Ph.D. (Cantab.)

ELECTRICAL ENGINEERING AND RADIO DEPARTMENT

Required, to commence duty on the 1st January, 1955, an ASSISTANT LECTURER in ELECTRONICS, including RADIO. Applicants should be well qualified and have had good industrial experience. Teaching experience would be an additional recommendation. Salary in accordance with the Burnham Technical Scale for Grade A Assistants, viz., £450–£725, plus appropriate allowances for degree and training. In fixing the commencing salary allowance will be made for previous teaching and industrial experience.

Further particulars and an application form may be obtained from the Director of Education, Education Office, Westoe Village, South Shields. Completed application forms should be forwarded to the Principal of the College not later than the 16th October, 1954.

A. J. W. JEFFERY,
E5829 Director of Education.

SURREY EDUCATION COMMITTEE

KINGSTON TECHNICAL COLLEGE

FASSETT ROAD, KINGSTON-ON-THAMES

LABORATORY TECHNICIAN

Required as soon as possible, LABORATORY TECHNICIAN for Radio and Light Electrical Laboratories. Duties include construction, maintenance and repair of electronic and electrical apparatus. Candidates must have experience in electrical work and have reached the standard of the Ordinary National Certificate in Electrical Engineering. Preference given to holders of Higher National Certificate or equivalent. Salary, £395 by £15 to £440 by £20 to £460 p.a., plus London Weighting, £30 for men of twenty-six or over. N.J.C. conditions of service, including superannuation.

Applications to the Principal as soon as possible. E5802

NATIONAL COLLEGE FOR HEATING, VENTILATING, REFRIGERATION AND FAN ENGINEERING

LECTURER IN FAN ENGINEERING

The Governors invite applications from suitably qualified candidates for the post of LECTURER in FAN ENGINEERING at the College. Applicants should preferably possess a Degree in Engineering and have had good industrial experience.

The commencing salary of the post is £1015 per annum, rising by annual increments to a maximum of £1115 per annum.

Further particulars of the post and forms of application may be obtained from the undersigned.

FREDK. J. PACKER,
Clerk to the Governors.

Borough Polytechnic,
Borough Road,
London, S.E.1. E5834

THE NORTH OF SCOTLAND COLLEGE OF AGRICULTURE

ASSISTANT LECTURER IN AGRICULTURAL ENGINEERING

Applicants for this post should possess a Degree in Engineering and/or in Agriculture, with practical experience of farm implements and machinery. Salary scale according to age and qualifications on scales ranging from £360 to £835 per annum, plus pay addition £36 12s. to £66 14s. Superannuation scheme. Applicants will be required to serve a probationary period of two years. Application forms and further particulars obtainable from the Secretary of the College, 41½ Union Street, Aberdeen, with whom applications should be lodged not later than 14th October, 1954. E5811

PUBLIC APPOINTMENTS

GOLD COAST LOCAL CIVIL SERVICE

GOLD COAST RAILWAY

ELECTRICAL ENGINEER/ASSISTANT ELECTRICAL ENGINEER

A vacancy exists for an ELECTRICAL ENGINEER/ASSISTANT ELECTRICAL ENGINEER, Railway Department of the Gold Coast Local Civil Service. Duties are to assist in the operation of the Electrical Workshop at Location and Takoradi.

Appointment is on contract for 2 tours in the salary range £1030–£2020 per annum, point of entry depending on experience, plus a gratuity of £37 10s. for each completed 3 months' satisfactory service. Free 1st class passages are provided for the officer, his wife and up to 3 children under 13 years of age. Government quarters are provided at a rental of £60–£90 per annum, and leave is granted at the rate of 7 days for each completed month of resident service after a tour of 18–24 months.

Candidates between 23 and 45 years of age must have passed Sections A and B of the examinations for A.M.I.Mech.E. or A.M.I.E.E. or hold an Engineering Degree or diploma granting exemption from Sections A and B of the Institution's examination and have had 2 years' subsequent practical experience. They should have had experience in workshop and machine practice, and a knowledge of electrical and mechanical equipment of all types of cranes. They must have served an apprenticeship or served as a graduate student with a reputable firm combining both Mechanical and Electrical training. In addition they should have knowledge of low tension cable networks, distribution systems and their maintenance and they must be capable of controlling subordinate staff. Preference given to candidates with service in R.E.M.E., R.E. or R.A.

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1. giving briefly age, qualifications and experience. Mention the reference number BCD 110/13/07/D4. E5755

ADMIRALTY

ENGINEER OFFICERS IN ROYAL NAVY

A good career is offered to young men as ENGINEER OFFICERS, with permanent commissions, in the Royal Navy. There are three methods of entry :—

(1) Through the Britannia Naval College at Dartmouth. Competitive examinations are held in February, May and October, for entry in the following September, January and May, respectively. Candidates must be between 17 years and 8 months and 19 years of age on the first day of the month of entry.

(2) From University Graduates with a suitable Engineering or Science Degree. Candidates must be under 25 years of age on the 1st July for entry in the following September. Extensions may be allowed where the University course has been delayed by National Service.

(3) From National Servicemen who become Engineer Officers, R.N.V.R., and who are considered suitable for permanent commissions.

Engineer Officers specialise in marine, ordnance or aeronautical engineering and are trained to Degree standard. Their duties cover design development and research work as well as the operation and maintenance of equipment. There is practically no branch of mechanical engineering which is not covered by the three specialisations.

For further details apply to :—
The Secretary of the Admiralty, N.C.W. Branch, Queen Anne's Mansions, London, S.W.1. E5324

NATIONAL COAL BOARD

SITE ENGINEER

National Coal Board invite applications for a superannuable appointment as SITE ENGINEER for work in connection with gas and steam turbine power plants. The successful candidate, although a member of headquarters production engineering staff, will for the most part be required to work outside London.

Applicants must have wide experience in modern power plant operation, preference being given to those with experience in the design or operation of gas turbines. The duties will involve operation of the plant on site and also visits of considerable duration to manufacturers' works for the shop testing of the equipment.

The salary will be within a range £1100 to £1550 per annum, according to qualifications and experience.

Apply in writing, giving full particulars (in chronological order) of age, education, qualifications, and experience (with dates), to National Coal Board Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking the envelope TT/850. Original testimonials should not be forwarded. Closing date 22nd October, 1954. E5820

WAR DEPARTMENT

FLEET REPAIR UNIT, R.E.M.E.

OVERSEERS

Three OVERSEERS are required by War Department, Fleet Repair Unit, R.E.M.E. Duties include survey of vessels and their machinery, writing of specifications for overhauls, and supervision of work in contractors' yards in connection with steam and diesel coasters, small steel craft and wood launches, both high and low speed. Headquarters in Kingston-on-Thames, but duties involve travelling to any part of the U.K. First-Class M.O.T. Certificate or Higher National Certificate essential, with marine experience, including high-speed diesel and petrol engines, with knowledge of wood hulls, desirable. Salary £665–£780 p.a. (consolidated). Allowances for duty travel and subsistence. Posts may become pensionable.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting Ref. C 244/53A. E5791

PUBLIC APPOINTMENTS

FEDERATION OF MALAYA

MUNICIPALITY OF GEORGETOWN, PENANG

APPOINTMENT OF ASSISTANT ENGINEER

Applications are invited for the above post in the Municipal Engineer's Department. Applicants must be British subjects, preferably between the ages of 25 and 35 years.

The minimum qualification requirements will be one of the following :—

(a) Passed Final Parts I and II (Group I or IV) of the Associate Membership Examination of the Institution of Civil Engineers ;
(b) Passed parts of the Testamur Examination of the Institution of Municipal Engineers equivalent to (a) ;
(c) Holds an appropriate University Degree or Diploma in Civil or Municipal Engineering exempting from (a) ;

and at least two years' practical experience in civil or municipal engineering works subsequent to (a), (b) or (c), preferably in connection with sewerage construction works.

The appointment in the first instance will be on a three years' agreement, but the successful candidate will be offered an appointment on the permanent staff following satisfactory completion of the agreement. The basic salary will be in the Professional Officers' Salary Scale of $528–36A–852/912–36A–$1200 p.m., the point of entry being determined by the successful candidate's qualifications and experience. The minimum qualifications prescribed above would carry a commencing salary of $600 p.m.

An expatriation allowance is payable and at present there is also a cost-of-living allowance in addition to basic salary. At present rates, the total annual emoluments with a basic salary of $600 p.m. are as follows :—For a bachelor, £1302 ; for a married man, £1575 ; for a married man with children, £1666. ($1 equals 2s. 4d. sterling.)

A transport allowance will be paid for the use of a motor-car on duty.

Free air passage will be provided for the successful candidate with half-pay and allowances during the travelling period or approved allowance to cover baggage and other charges. Free sea passages will be provided for wife and children under 12 years of age.

Accommodation with heavy furniture will be provided at a low rental or an allowance given in lieu.

The successful candidate will be required to pass a medical examination and to contribute to the Council's provident fund.

Applications in duplicate, with full personal and technical information and copies of three testimonials in duplicate, to be submitted to Messrs. Allen and Williams, 1, Victoria Street, London, S.W.1, before Thursday, 21st October, 1954. E5774

GOLD COAST LOCAL CIVIL SERVICE

ELECTRICITY DEPARTMENT (GOLD COAST)

MECHANICAL ENGINEER

A vacancy exists for a MECHANICAL ENGINEER, Electricity Department, in the Local Civil Service of the Gold Coast.

Duties are to assist the Chief Electrical Engineer in supervising the operation and maintenance of generating plant in a number of electricity undertakings, and the planning and installation of extensions to plant.

Appointment is on contract, for two tours of 18–24 months, in the salary scale £1130–£2020 per annum, point of entry depending on experience. A gratuity of £37 10s. is payable for each completed three months of satisfactory service. Free first-class passages are provided for the officer, his wife, and up to three children under 13 years of age. Government quarters are provided, if available, at a rental of £60–£90 per annum. Leave at the rate of seven days per month of resident service.

Candidates should be between the ages of 23 to 45 and should either have an Engineering Degree or Diploma carrying exemption from Sections A and B of the examinations of the Institution of Mechanical Engineers with two years' subsequent experience or have passed the Institution's examinations.

Candidates should have had experience of the erection, operation and maintenance of compression ignition oil engines up to 1200 H.P., driving three-phase A.C. generators.

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference BCD. 145/13/01/D4. E5730

CITY OF NOTTINGHAM

WATER DEPARTMENT

MECHANICAL ENGINEERING ASSISTANT

Applications are invited for the permanent, pensionable appointment of MECHANICAL ENGINEERING ASSISTANT ; salary, Grade A.P.T. VIII of the National Scale, viz., £785 by £25 to £860. Candidates should be not more than 45 years of age, should possess an Engineering Degree, and/or be Corporate Members of the Institution of Mechanical Engineers, and should preferably have had electrical and diesel engine experience. The National Joint Council have recently recommended an adjustment in the salary scales which would, on adoption by the Corporation, result in the salary being increased to £840, rising by increments in two years to £900 per annum.

Applications, giving the names of two referees, should be addressed to the Engineer and General Manager, Water Department, Castle Boulevard, Nottingham, not later than the 15th October

T. J. OWEN,
Town Clerk.

Guildhall,
Nottingham. E5805

PUBLIC APPOINTMENTS

HER MAJESTY'S COLONIAL SERVICE

MATERIALS BRANCH, PUBLIC WORKS DEPARTMENT, KENYA

ENGINEERS

Appointment on contract/gratuity terms ... salary in the incremental range £1135–... plus substantial gratuity payable on satisfactory completion of contract.

Candidates, who (a) should be under 26 ... age, must hold a recognised University ... Diploma in Civil Engineering carrying ... from Final Parts I and II of the A.M.I.C.E. ... tion or be A.M.I.C.E. and have had at ... years' approved practical experience, of ... least one year must have been spent on ... testing and control, soils, concrete, bitu... or (b) be under 40 years of age and ... Honours Degree in Physics, including ... Applied Mathematics, and a sound ... electronic and light electrical engineering.

For the selected candidate holding ... (a) duties will mainly involve the control ... tion of tests in the laboratory and field on ... stabilisation and on materials used on ... roads and water construction works ; the ... candidate holding qualification (b) will be ... undertake the testing of materials by elec... light electrical engineering methods.

Full details on application.

Apply in writing to the Director of Re... Colonial Office, Great Smith Street, Lond... giving briefly age, qualifications and ... Mention the reference number BCD/112...

BRITISH ELECTRICITY AUTH...

SOUTH EASTERN DIVISION

CONTRACT NO. 2/BRIGHTON ...

Applications are invited for the appoint... INSPECTORS (2) to supervise under the ... Engineer the construction of a tunnel und... ham Harbour, Sussex, for the British ... Authority. The works include the const... two shafts and a 6ft. diameter tunnel betw... lined with cast iron segments. It is antic... the excavation will be mostly in chalk and ... stantial part of the work will be carried ou... pressed air.

Applicants must have had previous exp... tunnelling works of this class ; they must ... ally fit and passed by the doctor for wor... pressed air up to 35 lb. per square inch.

The salary will be up to £15 per week, dep... experience, and applicants may be require... up their duties by 18th October. The app... will be terminable by one month's notice ... side, and the duration is expected to be ... months, subject to satisfactory service.

Applications, giving full details of age ... ence, together with the names and address... persons to whom reference may be ma... previous employment, are to be sent to the ... Engineers, Lemon and Blizard, 59, Tufto... Westminster, S.W.1, not later than Mo... October.

W. C. PARKER,
Divisional Co...

British Electricity Authority,
South Eastern Division,
Lower Ham Road,
Kingston upon Thames, Surrey.

FOREIGN OFFICE

COUNCIL FOR TECHNICAL CO-OPERATION IN SOUTH AND EAST ASIA

PROGRAMMING AND PROGRE... WORKS ENGINEER

The Foreign Office invites application ... Colombo Plan for an appointment as PR... MING AND PROGRESSING WORK... NEER in Burma (based on Rangoon). ... consist of programming and co-ordinating ... of large building developments, all constru... including water supply and sanitation ; ... work and co-ordinating supply and ... materials and labour. Will also be requir... officers of the National Housing Board of ... of Burma. Candidates must be fully qua... Engineers of at least ten years' standing ... less than five years' experience of progra... progressing large building or housing ... Two years' contract initially with Britis... ment. Salary : £1300 p.a., plus tax-free ... of £1500 for a married man and £80... For further information and application f... to Ministry of Labour and National Servi... House, 26–28, King Street, London, S.W... A.12 BE. 15/53.

THE PARSONS AND MA... ENGINEERING TURBIN... RESEARCH AND DEVELOP... ASSOCIATION

RESEARCH ENGINEER

The Parsons and Marine Engineeri... Research and Development Association ... RESEARCH ENGINEER for work in c... with full-scale steam trials on marine ... machinery. Candidates should be about ... of age and should preferably possess a goo... Degree in Mechanical Engineering. A good... be paid depending on age, experience an... tions.—Apply in writing to Research ... Pametrada Research Station, Wallsend, N... land.

THE ENGINEER

OCTOBER 1, 1954

Reactor School at Harwell

IN order to encourage industry to take a greater part in the development of atomic power, the United Kingdom Atomic Energy Authority has opened a Reactor School at Harwell. The school provides, for a fee of £250, a three-months' course of training for staff from industrial concerns to learn the techniques by which heat from atomic piles can be converted into useful power. At first, priority is to be given to the staffs of firms already acting as contractors to the Atomic Energy Authority, and some new graduate members of the Authority's own staff are also to be trained in the school. Three courses are to be held at the school each year, beginning in September, January and May, and the syllabus includes lectures and individual instruction in nuclear physics, reactor physics, metallurgy and reactor engineering, as well as experimental work. The lectures are given by experts drawn from various divisions at Harwell and by the full-time staff of the school. About twenty-five students can be accommodated, and it is expected that all students will be physics or engineering graduates or else have had considerable theoretical and practical experience in at least one branch of science or engineering. Mathematics up to subsidiary degree standard is necessary, particularly for the reactor physics lectures. Speaking at the opening of the school on Monday morning, Sir John Cockcroft, Director of the Atomic Energy Research Establishment, said that the main objective was to enable British industry to design and build economic power units as early as possible. He envisaged a development period of eight years, during which Mark I power stations would have been built and operated for five or six years, and during which improved Mark II stations—and possibly even a Mark III station—would have been designed and built. It should then be possible to build nuclear power units on a scale adequate to do the job of 20,000,000 tons of coal a year. That, Sir John thought, could easily be achieved between 1965 and 1970, and perhaps earlier if the need was great.

Aircraft Electrical Systems

A VACATION school on "Aircraft Electrical Systems" was held in the Electrical Engineering Department of Imperial College, London University, last week. It was attended by nearly seventy engineers drawn from the electrical and aircraft industries, the research organisations and the College of Aeronautics. The purpose of the school was to bring out the scientific principles underlying the design and application of all forms of equipment used in aircraft electrical systems, in relation to both present and future requirements. The opening address was given on Monday morning, September 20th, by Sir Frederick Handley Page. After drawing attention to electrical and aeronautical engineering as the two newest branches of the art, he referred to the interesting problems which have arisen as they have progressively come together, and to the need for closer liaison between members of these two branches. He then pleaded for simplicity of equipment, and hoped that eventually one very reliable and safe system, simple because it needed no special safety or emergency devices, might suffice for any aircraft. His last theme was the need for electrical manufacturers to be one stage ahead of aircraft designers. In an "Introductory Survey" Mr. D. F. Welch, of the British Thomson-Houston Company, Ltd., outlined the problems facing the aircraft electrical engineer. He mentioned that since 1940 power requirements have risen from 1kW to 200kW for large aircraft: with these powers the potentially destructive power of a fault had focused fresh attention on circuit protection. He emphasised that the introduction of power-operated controls and electrical operation of essential flying instruments means that the safety of an aircraft is now dependent on the maintenance of the electrical power supply. Mr. M. Hancock, of the Royal Aircraft Establishment, Farnborough, spoke next on "Environmental Conditions and Functional Requirements," emphasising that these led to acute differences between aircraft and ground-based electrical engineering practice. He showed how operation at high altitude increased arcing problems in switchgear and decreased machine cooling, while the wide temperature range over which the equipment must function increased insulation and lubrication problems. He went on to discuss mechanical problems, vibration, weight and bulk considerations, and other factors, and stressed the very great importance of reliability for all kinds of equipment. In the third lecture Mr. J. H. Rea, of Rotax, Ltd., dealt with "Power Systems." The more specialised lectures commenced with that of Mr. R. F. Sims, of the Royal Aircraft Establishment. In the first part of his lecture, on "Brushwear Problems," he spoke about the physical causes of the abnormal brushwear experienced at high altitudes, and then discussed remedial measures. The second part of his lecture was concerned with "Vibration Problems." Dr. C. S. Hudson, of the Royal Aircraft Establishment, in surveying "Cooling Problems," discussed the effects of radiation, natural and forced convection, and conduction, and discussed methods of calculating the pressure head required in a cooling system. He described possible future methods of cooling by means of liquids or vapours. The topic of "D.C. Machines" was covered in the next lecture by Mr. B. Adkins, of Imperial College, London University. On Wednesday, September 22nd, members visited the works of Vickers-Armstrongs, Ltd., at Weybridge, where a demonstration of the operation of an all-electric undercarriage had been arranged. In the seventh lecture, on "Electrical Installation Engineering," by Mr. H. Zeffert, of Vickers-Armstrongs, Ltd., many kinds of plugs, sockets, terminal blocks and cables were described and demonstrated. He also discussed many other factors involved in installation engineering, including earthing and banding, cable identification systems, and the problems caused by pressure breaks. On Thursday, Mr. W. Phillip, of Rotax, Ltd., continued on the main theme with a lecture on "A.C. Machines." He discussed the problems of alternator design, both for the long speed range machines now in use and for the constant speed machines which will be required when a constant-speed drive, taken either from an engine-driven hydraulic gear or from a separate turbine, becomes available. Conversion equipment, using invertors, rotary transformers, or motor-alternators, and induction motors, were also considered in some detail. The topic of machines was followed by that of "System Operation and Protection," reviewed in the lecture by Mr. K. J. Payne, of the British Thomson-Houston Company, Ltd. In the last of the specialised lectures Mr. A. Grieve, also of the British Thomson-Houston Company, Ltd., discussed "Switchgear." A concluding survey, entitled "Future Trends," was made by Mr. S. F. Follett, of the Ministry of Supply.

Glasgow Water Department's Annual Report

WE have received a copy of the annual report for the year ended May 31, 1954, of Mr. S. Canvin, the chief engineer and manager of the water department of the corporation of the city of Glasgow. The average consumption of water in Glasgow increased to 87·44 m.g.d. during the year under review, from 86·1 m.g.d in the previous year. Constructional activity, as measured by its cost, was the highest so far recorded, and the increase in consumption was in part due to the connection of 7704 supplies to new houses. Twenty-four miles of distribution mains were laid for these new supplies. Apart from this considerable activity on the distribution of supplies, new works on the department's system of mains supply also made good progress. Construction of the Clyde water tunnel was started, and the west main, from Milngavie to Paisley Road, was laid except for the tunnel portion; part of this main was brought into use. The first instalment of the Glen Finglas scheme was provisionally approved by the Secretary of State for Scotland. The last instalment of the department's original Loch Katrine works, which were started in 1855, was virtually completed during the year; this work involved siphon pipelines across the Endrick and Blane valleys.

Junior Institution of Engineers

ON Thursday, September 23rd, the Junior Institution of Engineers opened its new headquarters at Pepys House, 14, Rochester Row, Westminster, S.W.1, the ceremony being performed by Viscount Falmouth. Previously, the Institution had rented offices at 39, Victoria Street, where it had been since 1901. The new premises include a main lecture room on the ground floor, 42ft by 28ft in size, with a platform, demonstration bench and projector equipment. The secretary's offices are also on the ground floor, and there is a library and members' lounge on the first floor; the lower floor consists of a hall of similar size to the main hall, which, it is hoped, will be used to increase the social activities of the Institution. The whole premises, which are the first that the Institution has owned, are well appointed and will give the Institution greatly improved amenities for its future activities.

Reopening of Fulbourn Pumping Station

ON Friday of last week Mr. Henry Willink, vice-chancellor of Cambridge University, chairman of the Waterworks Company, reopened the Fulbourn Pumping Station at Cambridge. The station, which was constructed in 1888, was equipped with beam engine pumps having a capacity of 1,000,000 gallons per day, and they continued to operate until 1920, when the station was closed down as being inefficient. New electrical plant, which has been duplicated to avoid any possibility of breakdown in the water supply, has been installed and is capable of varying the rate of pumping from 1,000,000 to 2,000,000 gallons per day. The equipment includes a "jet tank," which serves to remove dissolved carbon dioxide in the water. In a short speech at the ceremony, Mr. Willink recalled a statement, made by Mr. Ernest Marples, which pointed out that there were still about 1000 separate water undertakings in Great Britain, and that before the country could possess an efficient water industry it would be necessary to amalgamate many undertakings into larger bodies. These should be of sufficient size and financial strength to be able to command the best skilled advice and supervision essential to provide adequate and reliable supplies of pure water. Mr. Willink expressed his concurrence with this statement and his regret that so little had been accomplished in the direction of amalgamation since the Water Act of 1945. He went on to assure those who operated waterworks in the county that the Cambridge company was willing to give help to its smaller neighbours and instanced several districts to which water in bulk was being supplied to supplement inadequate local resources. Mr. Willink said that his company intended to continue assisting its less fortunate neighbours and was prepared to extend that help, but he thought that it was in the public interest to consider the overall benefits and practicability of his company taking over the water supply responsibilities of the smaller undertakings by extending the statutory area of the company's supply.

Radioactive Isotopes for Measuring Piston Ring Wear

By J. H. DETERDING, M.A.,* and A. DYSON, M.A.*

Since Harwell began to produce radioactive isotopes much work has been started to discover how best such materials can be used for technological research. This article describes the use of piston rings of normal composition irradiated in the Harwell pile for the determination of wear. The radioactive constituents are listed, safety precautions mentioned and counting methods discussed. Some results are given. It is concluded that the method is particularly suitable for following wear in detail over short intervals of time, but less suitable for long-term investigations.

THE wear of moving parts forms a considerable proportion of the depreciation of the capital assets of society and in many cases it is possible to reduce this wear very considerably. There is a particularly large scope for such a reduction in the wear of cylinder bores and piston rings in internal combustion engines.

Thus, there arises the need for an accurate test for the comparison of engine wear under various conditions. However, wear is a very variable quantity and it is notoriously difficult to make comparative measurements with a sufficient degree of confidence in the reality of any differences in wear which experiment may disclose.

Two alternative courses are open to the worker faced with this situation. One is to accept the large variation in results from test to test and to perform a sufficient number of tests to enable comparisons to be made with the required precision.

The other alternative is to use a method which reduces considerably the random variation of the results. A large part of this variation is caused by the need to dismantle the engine, clean and measure the components and reassemble. Cleaning of the components, e.g. piston rings, may render them liable to accelerated corrosive or abrasive wear for the first few hours of the following run, and the steady wear rate reached after this initial period may also vary from reassembly to reassembly. These difficulties may be overcome if the wear can be estimated without disturbing the engine in any way. This is possible because wear products enter the film of lubricating oil which is always present on the cylinder wall, and drain down to the crankcase, where they may be detected in samples of the engine lubricating oil.

One method which has often been used is to analyse the lubricating oil chemically for iron. Unfortunately, the sensitivity is low and comparatively long runs are required before useful results can be obtained. On longer runs, however, corrections for oil consumption and make-up become important, but they can be made only on an approximate basis. Furthermore, the iron may not have come only from the parts of interest ; for example, oil containing corrosive acids may dissolve iron from the crankcase walls.

The use of radioisotopes offers an alternative method which has many advantages. The wear products detected by their radioactivity in the oil can have originated only from the part which has been irradiated, and the sensitivity of detection is very high. The most convenient part of the engine to irradiate is the top piston ring. Wear of cylinder bores may be more important in practice, but the wear of the piston rings usually varies in a manner similar to that of the bores. Cylinder bore wear is very difficult to measure with accuracy even when conventional methods are used. The wear rate is very uneven, and apparently undergoes severe long and short-term variations. It is therefore necessary to run for at least a few hundred hours and to use new components for each test. This further increases the variability of the results. In practice, therefore, most conventional short-term wear measurements are made on the piston rings, the wear rate of which is more regular. The top ring of a given piston has the highest wear rate and is therefore the most important.

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In the United States the radioisotope method has been in use for some years in the study of the wear of top piston rings of both diesel† and petrol‡ engines. In this article some account is given of the application of this method, primarily for lubricating oil research, at the Thornton Research Centre, where it has been developed to record wear continuously and automatically.

Isotopes and Activities

Piston rings of normal composition are used for wear determination and irradiation of such rings in the Harwell pile produces a number of radioisotopes as shown in Table I. In addition, an undetermined ring constituent contributes a high initial activity with a half-life of a few days.

After the ring activity has been allowed to decay for about four weeks, the main sources of beta radiation are the P^{32} and Fe^{59} isotopes, and of gamma radiation the Fe^{59} and Co^{60} isotopes. The phosphorus is concentrated to a large extent in the grain boundaries and is therefore irregularly distributed compared with the iron and cobalt, the latter being in solid solution in the ferritic or

TABLE I—*Radioactive Constituents of an Irradiated Piston Ring*

Element	Relative amount in ring % *weight* (approx.)	Active isotope	Half life	Radiation energy (MeV) Beta	Gamma	Activity μc/gm of ring after 4 weeks at 8×10^{11} *n*/cm²/sec (approx.) On removal from pile	After 30 days
Iron	92	Fe^{55}	~4 years	(*K* capture)		250	247
		Fe^{59}	47 days	0·46 (50%)	1·3	53	34
				0·26 (50%)	1·1		
Chromium	0·35	Cr^{51}	26·5 days	(*K* capture, 97%)	0·32, 0·27 (3%)	190	87
Cobalt	0·016	Co^{60}	5·3 years	0·31	1·33, 1·17	7	7
Phosphorus	0·5	P^{32}	14·8 days	1·69	—	300	74
Silicon	2·5	Si^{31}	2·85 hours	1·65, 0·67	—, —	52	Negligible
Manganese	1·0	Mn^{56}	2·6 hours	2·81 (50%), 1·04 (30%), 0·75 (20%)	2·06, 1·81, 0·82	25,600	Negligible

† P. L. Pinotti, D. E. Hull and E. J. McLoughlin : *Trans. Soc. Automot. Engrs.*, N.Y., 1949, 3, 634.

‡ H. D. Jackson, F. C. Burk, L. J. Test and A. T. Cowell : *Trans. Soc. Automot. Engrs.*, N.Y., 1952, 6, 518.

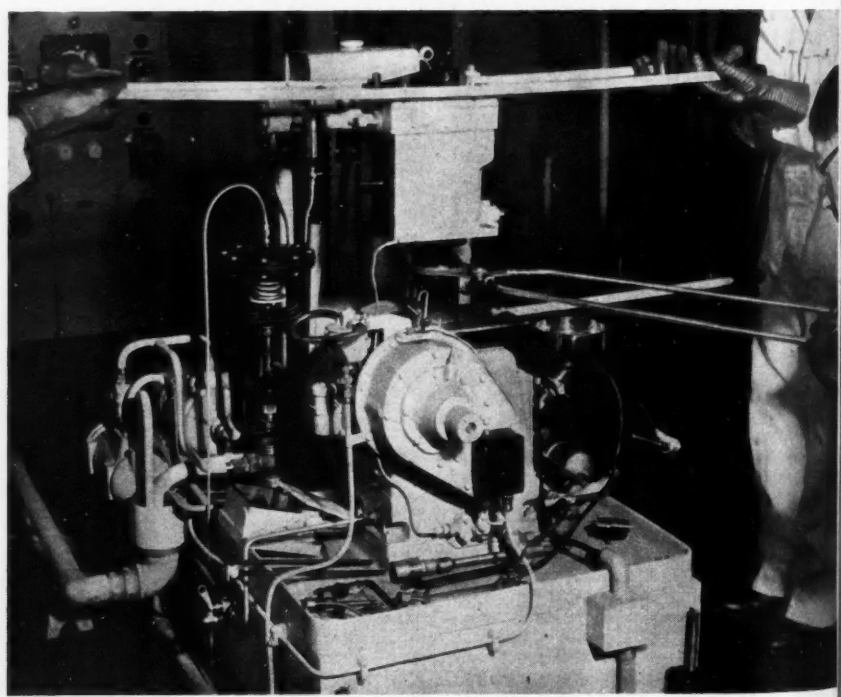

Fig. 1—Assembling an engine with a radioactive top piston ring

pearlitic matrix. In practice it was found that calibration of ring weight loss against gamma activity in the oil was satisfactory ; but the ratio of beta to gamma activities in the engine oil varied, indicating that the beta activity of an oil sample was not proportional to the wear of the piston ring.

It was therefore necessary to measure the gamma radiation and to accept a correspondingly low detection efficiency when using Geiger-Müller counters. However, the use of gamma counting is more convenient with systems in which oil is continuously

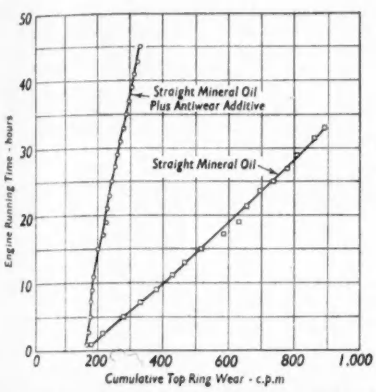

Fig. 2—Top piston ring wear. Results obtained with Geiger-Muller counter and automatic count recording apparatus

circulated past the counter, and the detection efficiency may be greatly improved by the use of a scintillation counter.

Safety Precautions

After removal from the pile, the rings are retained at Harwell for a few days to allow the short-lived manganese isotope to decay to a level permissible for transport by rail in a lead container. The activity of a ring is then a few millicuries.

After the decay period of about four weeks the ring is fitted to the engine with the use of long-handled tools (Fig. 1). Eyeshields and gloves are worn by everyone exposed to the unshielded ring to guard against the beta radiation. Once the ring is assembled in the engine the shielding by the water jacket and cylinder reduces the radiation rate to less than 12½ milliröntgens per hour at 2ft from the engine. Film badges are worn by the operators which have shown that no more than one-fifth of the permissible dose in any one period has ever been received.

Care is taken to avoid contamination of the person by radioactive debris in the engine oil, and gloves are worn when handling oil samples. The used oil is diluted at least 20 : 1 by inactive oil from other engines and the specific activity is thereby reduced to a harmless level for disposal as waste.

Geiger-Muller Counting Methods

Oil Sampling Method.—In the initial phase of the work at Thornton, oil samples were taken from the engine crankcase. The engine was a small industrial vertical, single-cylinder, liquid-cooled, four-stroke petrol engine with a bore and stroke of approximately 3in. A volume of approximately 700ml of oil was run into the annular space between two concentric glass cylinders of radii 1·25 and 4·0cm. The sample container was mounted on a scale pan and the sample was taken to a constant weight. A Geiger tube (20th Century Electronics' type G10Pb) was then inserted into the central cylinder and the whole placed inside a lead castle. Pulses from the counting tube were amplified and fed to a scaling unit (type 200). Counting proceeded for 50–100 minutes and the sample was then poured back into the engine in order to permit thorough mixing before the next sample was taken.

Some oil samples were retained and counted at intervals of a few days in order to establish a decay correction, by means of which observed sample activities could be corrected to a standard time. After some of these samples had been standing for approximately three months, vigorous stirring and repeated decanting of the oil produced no change in the counting rate. It was therefore concluded that any gravitational sedimentation of the wear particles did not affect the results.

The plots of logarithm of counting rate against time were curved owing to the presence of iron and cobalt activities with different half-lives. For convenience of interpolation straight lines were obtained by plotting the activities against the quantity $(\frac{1}{2})$ raised to the power $t/47$, where t is the time in days since the ring was removed from the pile. The half-life of the iron isotope is forty-seven days, whereas that of the cobalt isotope is about five years.

Continuous Oil Circulation Method.—In order to run the uni. with only intermittent supervision, and to maintain a relatively

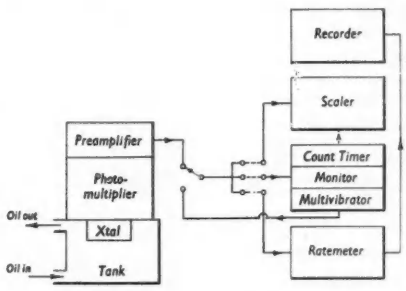

Fig. 4—Block diagram of scintillation counting equipment

constant oil charge in the engine, lubricating oil from the crankcase was circulated continuously through a counting cell, and returned to the crankcase. The counting cell was made in brass to the same general shape and size as the oil sample containers used previously. The output of the scaling unit, one pulse for every hundred counting tube pulses, was fed to a bank of twenty-four mechanical registers. At intervals which could be preselected at one, two or four hours the output was automatically switched from one register to the next. Thus, the equipment produced a record of the number of hundreds of counts in successive intervals of time.

Results and Limitations.—The results were obtained in the form of a graph of counting rate against engine running time. After suitable corrections for radioactive decay, oil consumption and make-up, &c., the counting rate was proportional to the cumulative top ring wear.

The relation between these counting rates and actual ring weight losses was obtained by weighing the ring before and after a series of runs. This process was repeated five times in succession on the same ring and gave a calibration factor consistent within a range of ±7½ per cent. One milligramme of ring weight loss corresponded to approximately fifty counts per minute. This calibration applied to a ring which had been irradiated for four weeks in the Harwell pile at a pile factor of 8. The typical results shown in Fig. 2 were obtained with a petrol engine running at a low jacket temperature.

Valuable results were obtained with this equipment, but its performance was limited by statistical fluctuations of the comparatively low rate of increase of counting rate. It was necessary to count for at least one hour in order to obtain the necessary accuracy, and for some purposes it would be an advantage if this time could be reduced considerably.

An increase in the counting rate for a given quantity of wear products was therefore required. An increase by a factor of approximately 2 could be obtained by irradiating the ring for a longer period, while another factor of 2 or 3 may be obtained by

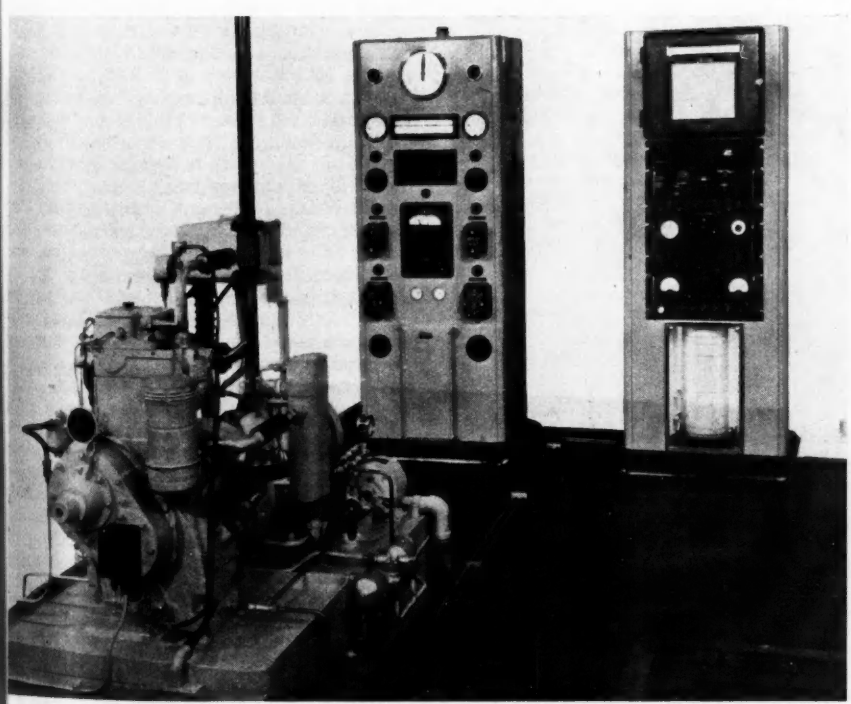

Fig. 3—General view of engine, control panel and scintillation counting equipment

using a battery of Geiger-Müller tubes. The volume concentration of active wear products in the lubricating oil is very low and a further small increase in counting rate may be obtained by increasing the volume of the oil counting cell. However, a large increase of the volume of oil in circulation was undesirable, while the optimum counting rate for a given weight of active material is approached rapidly as the volume of oil in the counting cell becomes comparable with that in the remainder of the system. As the minimum permissible counting time

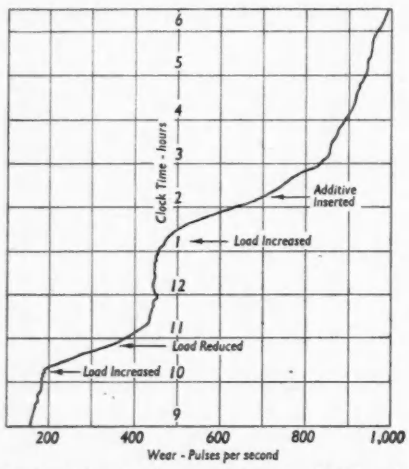

Fig. 5—Automatically recorded trace of piston ring wear against time, showing effect of engine load and anti-wear additive

for a given degree of statistical fluctuation depends approximately on the cube root of the counting rate for a given quantity of wear products, it appeared that little benefit would be obtained by the use of the above methods. Only the use of the highly efficient scintillation counter offered the possibility of a worthwhile advance.

Scintillation Counting and Continuous Recording

Apparatus.—Preliminary experiments on oil samples using a large thallium activated sodium iodide crystal and improved geometry showed that the count rate was increased to about fifty times that given by a Geiger-Müller counter. With a rate meter having a long time constant, statistical fluctuations were thus reduced sufficiently to allow continuous recording to be employed with advantage. The equipment for this purpose is housed in the right-hand panel, shown in Fig. 3, and a block diagram is shown in Fig. 4.

The crystal detector is housed in a lead castle at the bottom of the panel. This contains a brass tank, having a volume of about 820ml, through which the oil is pumped, after cooling to about 25 deg. Cent. The tank is recessed to fit the crystal container, and the oil circulates round it. The crystal (Harshaw Chemical Company) is in the form of a cylinder of 1¾in diameter and 2in height. A photomultiplier (EMI type 6260) and a preamplifier, a single pentode stage, are housed with the crystal in a light-tight assembly. With the detector shielded by 1½in of lead, the background 12ft away from the engine is about twenty pulses per second.

The pulse output from the detector is fed to the scaler (Dynatron 1009B), which is used to measure low count rates, and to the ratemeter (Ekco N522), from which the output fed to a potentiometric recorder (Kent) gives a continuous record of count rate. The monitor unit provides a set of calibration pulse rates from a multi-vibrator, and incorporates a timer unit, which is used to switch on the scaler counts for preset periods. A cathode ray tube in the monitor unit with time base and amplifiers can be used either to display the pulses or for fault finding; inputs and outputs of the various units are brought to a distribution panel where they can be interconnected as desired.

With this apparatus increases in count rate from a few pulses per second per hour up to several hundred pulses per second per hour have been recorded under various engine running conditions. An increase of 40 pulses per second in the counting rate represents about 1 milligramme of ring wear.

Time Constant and Stability.—In order to reduce statistical fluctuations in the recorded count rate the integrating time constant of the ratemeter was increased to four minutes by using external high-quality condensers. The response to a change in wear rate is thus delayed, but this is not serious compared with other unavoidable delays which occur whilst oil drains from the cylinder wall, mixes with the crankcase oil and circulates through the counting tank.

It was found that a considerable increase in overall stability could be obtained by working the preamplifier near to saturation. In practice, under such conditions, the change in count rate from an oil sample was less than 1 per cent for a 10 per cent change in discriminator bias voltage. Using a Co^{60} source, the fluctuations in the recorded trace at 500 pulses per second did not exceed those to be expected from the theoretical r.m.s. statistical fluctuations of about 0·2 per cent. Larger fluctuations are encountered when engine wear is recorded.

Results and Discussion

Figs. 5 and 6 show traces obtained during a public demonstration of this equipment at the Engineering, Marine and Welding Exhibition at Olympia in September, 1953. The engine was a small industrial diesel engine of approximately 3in bore and stroke, running at 1500 r.p.m. on a typical gas oil.

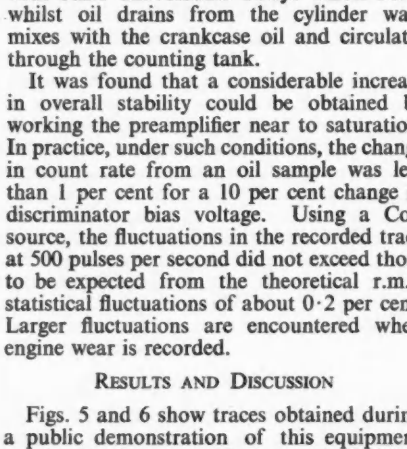

Fig. 6—Automatically recorded trace of piston ring wear against time, showing effect of engine jacket temperature

The wear rate at the low loading of approximately 1 b.h.p. was very low, as is shown by the almost constant counting rate at the beginning of the traces. When the load was increased to approximately 5 b.h.p. the wear rate increased markedly, approximately from 20 to 260 pulses per second per hour. These figures correspond to wear rates of about 0·5 and 6·5 mg/hr respectively. In Fig. 5 the wear rate decreased and again increased when the load was reduced and increased again, while finally the addition of a small quantity of anti-wear additive to the crankcase oil produces a decrease in wear rate in a ratio of approximately 6 : 1. Fig. 6 shows an increase in wear rate of approximately 2 : 1 when the coolant jacket temperature was reduced from 80 deg. to 25 deg. Cent. after the load had been reduced. Fig. 7 shows the effect of an anti-wear additive in reducing the wear rate of a chromium-plated ring; the counting rates are higher and the trace is smoother.

It will be observed that when an increase of wear rate occurs it takes place almost immediately after the change in engine con-

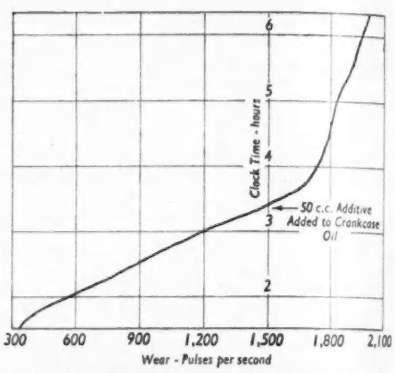

Fig. 7—Automatically recorded trace of piston ring wear against time, using chromium-plated ring.

ditions which has caused it; the delay observed on the trace is not much greater than that associated with the response of the instruments. On the other hand, a decrease in wear rate is usually observed some ½–1½ hours after the conditions have been changed. This delay is particularly noticeable in the additive response. From such results interesting calculations may be made concerning the circulation of the oil through the ring belt area.

The radioisotope method is thus particularly suitable for following wear in detail over short intervals of time. The effects of changes in operating conditions, changes in fuel, &c., can be observed rapidly and accurately. Thus the method is very useful in answering questions of the form "What is the effect of this change under these conditions?" However, it is less suitable for long-term investigations, e.g. in answering the question "What is the effect of changes in these conditions over the whole range of conditions likely to be used?" when the effect of one change may depend markedly on the other conditions. This would require a long experiment in which corrections for decay, oil consumption, &c., would become too difficult, and such questions are probably best approached by a factorial experiment using conventional methods. The radioisotope method is not suitable for comparing wear of different materials.

In considering the irradiation of other engine parts it is necessary to take into account size limitations on articles to be irradiated. There is no obstacle in principle to the measurement of cylinder bore wear by radioisotopes. It would be necessary to irradiate a thin sleeve in the thermal column and to accept a large reduction in specific activity. It would probably be necessary to use long scaler counts even with the scintillation counter. Even so, the total activity would be rather high, and the assembly of the engine would be difficult.

A variation of the method has also been used at these laboratories to study the transfer to the cylinder bore of material from an irradiated chromium-plated piston

ring. Cylinder bore wear is reduced by the use of a chromium-plated top ring, and it is thought that this reduction may be attributed to the adherence on the cylinder bore surface of chromium from the ring. When an activated chromium plated ring is used, a relative measurement of the amount of ring material adhering to the bore surface may be obtained by dismantling the engine and inserting a Geiger tube into the cylinder. In this way interesting information has been acquired concerning the influence of engine running conditions and of the lubricating oil on the transfer process.

Conclusions

While most research on wear of internal combustion engines must still be done by conventional methods, the radioisotope method shows advantages typical of its application in many other fields. Measurements can be made far more quickly and with greatly increased sensitivity, and in special cases it becomes possible to obtain results which could not have been obtained by other methods.

This particular application also shows advantages which are not always present when radioisotopes are used. The equipment is robust and suitable for routine engine laboratory use, and its ability to present the results in a form which may be readily interpreted is a very valuable feature.

Acknowledgments

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Commercial Motor Show

No. II—(*Continued from page* 413, *Sept.* 24*th*)

THE Commercial Motor Show, which is being held at Earl's Court, London, closes to-day, October 1st. Last week we began a review of some of the vehicles being shown for the first time by the A.C.V. group of companies and Leyland Motors, Ltd.

Another interesting vehicle at the Leyland stand is a new 6×6 cross-country chassis, to be known as the "Martian" (Fig. 4), which is the civilian counterpart of a military vehicle produced in quantity by Leyland for the Ministry of Supply. This vehicle is available as a truck or a tractor, and it is the latter version which is on show at Earl's Court. The fighting vehicle origin of the "Martian" is apparent in such details as its rigid construction, its fully articulated suspension, the air-pressure braking, and the three-axle drive. It has been designed to haul heavy loads over any terrain that could feasibly be tackled by a wheeled vehicle, and it is equipped not only to surmount the toughest off-the-road obstacles but also to withstand the effects of climatic extremes.

The show model has a wheelbase of 14ft 6in, a width of 8ft 3⅜in and an overall length of 24ft 10¼in; it is equipped with a 10-ton winch and can tow a trailer of 8 tons gross weight over the most difficult territory. In the alternative form, the "Martian" truck can carry a payload of 10 tons plus 1 ton of equipment and also tow a 7½ tons gross trailer in difficult cross-country conditions.

The power unit employed in the "Martian" is the six-cylinder Leyland 9·8-litre direct-injection diesel engine which in this application has been uprated to develop 150 b.h.p. at 2200 r.p.m. The torque is transmitted from the single dry-plate clutch to the four-speed main gearbox with synchromesh engagement of second, third and top gear. It is mounted as a unit with the engine. Driven by a short cardan shaft off the main box, the auxiliary gearbox has constant-mesh gears, providing two step-up ratios and one reduction ratio. It also incorporates the front-wheel-drive engagement gearing and a power take-off for the vehicle winch. In the front axle a single bevel gear reduction differential is employed with bevel gear drive to the road wheels. From the centre differential of the rear axle, the final drive is through a chain of gears housed in the centrally-pivoted walking beams at each side of the chassis.

The front suspension consists of a single transverse inverted semi-elliptic spring pivoted at its centre to the chassis frame; this is attached at the near side to the front axle torque member, the other end sliding between rollers. At the rear, longitudinal semi-elliptic springs are used, and Metalastik torque arms connect the axle to the frame.

Cam and double roller hydraulic, power assisted steering is provided. The "Martian" can wade without preparation up to a depth of 2ft 6in. All components are protected against condensation, electrolytic action and fungoid growth, and are treated to resist bacteriological attacks, corrosion, rot and erosion.

An example of a new series of high-powered under-floor-engined passenger chassis, specifically designed for export is the new "Royal Tiger Worldmaster," one of a range of models which have been introduced as successors to the now well-known Leyland "Royal Tiger" range.

Ten different models are offered with three different wheelbases for bodies with box dimensions 8ft wide by 36ft, 34ft or 30ft long.

The six cylinder, 11·2 litre diesel engine of 127mm bore and 146mm stroke develops 150 b.h.p. at 2000 r.p.m. and has a maximum torque of 450 lb-ft at 1100 r.p.m. It is positioned amidships below frame level. Shaft or gear drive is employed for all auxiliaries including the radiator fan. Mounted as a unit with the engine is a hydraulic coupling. A pneumo-cyclic gearbox incorporates its own gear-driven oil pump. Reference to this gearbox will be made later when some of the more interesting components at the exhibition are described. An unusually large worm-driven rear axle which incorporates involute-splined half-shafts is fitted.

The steering arrangement chosen for the "Worldmaster" series breaks away from Leyland tradition in that a worm and nut gear is used. A bronze nut, which is supported by the rocker shaft and swivels on two trunnions, is operated by a worm formed on the end of the steering shaft. The upper end of the shaft is located in a ball bearing mounted in rubber rings which absorb shock and vertical thrust and permit a slight rocking of the shaft caused by the angular movement of the nut.

The design of the front axle follows the previous Leyland practice, the stub axles being carried in phosphor-bronze bushes. Hardened steel thrust buttons take the king pin thrust centrally on a single point at the base of the pin, and the wheel hubs have large taper roller bearings.

The pneumatic brake system incorporates a valve which progressively releases air to the direct-acting brake chambers adjacent to each wheel. The chambers are diaphragm-actuated and operate the brake camshafts through short push-rods and levers. The liners are of moulded material, 5in wide at the front wheels and 8in at the rear, and the brake drums have deep cooling fins.

Among the exhibits of transport vehicles at the stand of Daimler, Ltd., Coventry, is the new version of the 20ft 4in wheelbase "Freeline" underfloor engined chassis. This chassis, specially designed for heavy service overseas, can be fitted with either a 150 h.p., six-cylinder, 10·6-litre Daimler engine or with the 8·4-litre Gardener 6 H.L.W. engine. Improvements and recent modifications introduced include a pressurised radiator and a modified blower fan. The blades of the fan have now been reversed so that the air is not being sucked back through the radiator, but pushed through it, with the result that the radiator can be kept much cooler and free from dust assimilation.

The C.V.G.5 lightweight double-deck chassis of 6ft 4in wheelbase, which was shown as a prototype chassis at the last Commercial Motor Show in 1952, this year appears in its production form. A number of improvements and modifications have been incorporated; the frame has been lightened by omitting the box-sectioning from the front

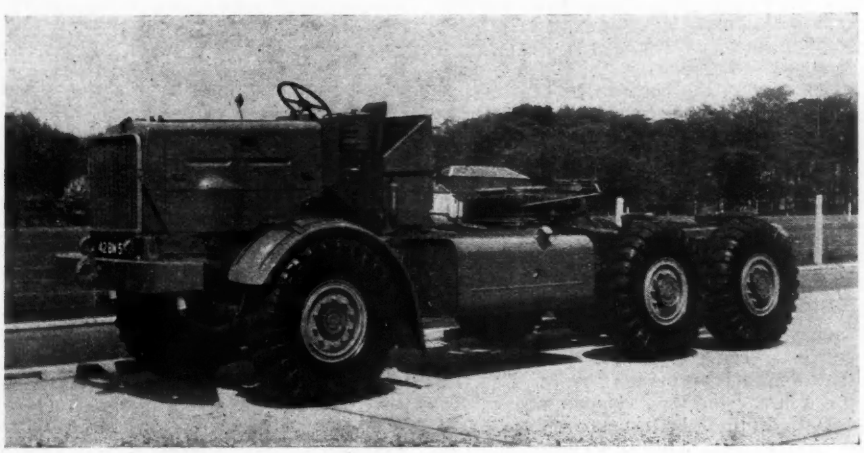


Fig. 4—The "Martian" cross-country tractor with six-wheel drive

Fig. 5—" Claymore " underfloor engined chassis for 3 and 4-ton payload

which has been replaced by local boxing at the spring hanger brackets and bump rubber stops, the intervening section being reinforced with flitch plates. Telescopic shock absorbers are now fitted at the front and back ; the steering box is of light alloy and the gear selection is by finger-tip gear control.

At the stand of Commer Cars, Ltd., the main interest centres around the recently introduced " TS3 " diesel engine, which now develops 105 b.h.p. and 270 lb-ft torque. It is available in 5-ton and 7-ton underfloor engined load carriers and in 10–12-ton tractor - trailer outfits, in addition to " Avenger " passenger models. The engine, an opposed-piston two-stroke with a Roots scavenging pump, has been fully described in THE ENGINEER of May 7th last.

By virtue of its layout it has a favourable power-to-weight ratio and is particularly suitable as an underfloor unit under the driver's seat.

Further refinement on these models is provided by the introduction of a four-speed synchromesh gearbox and an improved rear axle having a pressed steel casing. The 7-tonner is now available with power-assisted steering, which is particularly valuable in eliminating driver's fatigue on long journeys. Similar details have also been included in the design of the six-cylinder " Superpoise " range, covering four-wheel models from 2 to 5 tons, and 8–10-ton tractor trailing units. In addition, the 5-ton tipper is now fitted with an improved cab-controlled tipping gear, which enables the body to be held at any angle of tip.

Among the various exhibits at the stand of Dennis Bros., Ltd., Guildford, are two entirely new vehicles, namely, the " Ambulance " and the lightweight underfloor diesel P.S.V. chassis.

The lightweight coach has a new six-cylinder 5½-litre horizontal diesel engine of 87 b.h.p., developed from the Dennis vertical engine of the same capacity, and is equipped with a five-speed constant-mesh gearbox. The chassis is of orthodox construction, but provision has been made for a low front or rear entrance by the use of dropped extension members. The driving platform is set below frame height to provide good passenger visibility, a principle already established in the Dennis " Lancet " U.F. chassis. The vehicle has a wheelbase of 16ft 4in, an overall length of 30ft and an overall width of 8ft ; the gross weight of the chassis amounts to 20,820 lb.

The new " Ambulance " chassis (Fig. 6) is a lightweight vehicle powered by a four-cylinder vertical diesel engine of 3½in bore and 5in stroke, developing 55 h.p. at 2400 r.p.m. The engine, the four-speed synchromesh gearbox, and the radiator are mounted towards the rear of the cab, making it possible with normal bodywork to give access to the driver's seat from either side of the vehicle. The cabin foundation carries wheel arches, engine cowling and seat brackets, together with the floor plates, the latter forming a duct through which air passes to the radiator. A short front dash, which is part of the cabin structure, includes an integral bumper, radiator grille, head and side lamps. The chassis has an extremely low floor height, made possible by the use of a De-Dion axle, the differential casing of which is mounted on a central longitudinal cross member. The rear wheels are carried on short axles mounted on semi-elliptic springs which, in conjunction with coil springs give variable-rate suspension and good riding qualities. Front and rear axle movements are damped by piston and hydraulic shock absorbers respectively. The vehicle has a wheel base of 8ft 9in and a floor height of 1ft 9½in.

Another interesting exhibit near the Dennis stand is a platform vehicle for 8 tons payload, which, by the extensive use of aluminium alloy in both the chassis and the bodywork, has an unladen weight of just below 3 tons and, consequently, is not subject to the 20 m.p.h. speed limit.

The vehicle has been designed by Mann Egerton and Co., Ltd., in collaboration with Aluminium Development Association using mainly Dennis mechanical units, and is of integral welded construction. The underframe consists of two main " J " section longitudinal members, which are slotted to receive angle cross bearers ; the cross bearers as well as the longitudinal members are formed from sheet metal and strengthened by top flanges which are welded in position after the assembly of the cross bearers. The side raves are of extruded aluminium section and are bolted to the outriggers to facilitate replacement if damaged in service ; for the same reason the aluminium floor is riveted to the cross bearers. All-welded aluminium spring hangers at the front of the vehicle carry wearing shoes of mild steel to accommodate the spring shackles, while the rear spring brackets are made of steel, bolted to the length members by means of doubling plates. The underfloor engine is flexibly suspended from three points on members attached to the structure.

At the stand of Albion Motors, Ltd., Glasgow, the " Claymore " model with an underfloor diesel engine (Fig. 5), is being exhibited for the first time. It has been designed to meet the demand for a lightweight oil-engined vehicle with a flat engine mounted amidships, thus permitting the fitting of a driver's cab with a low floor level and providing easy and unobstructed entrance from either side of the vehicle. It is powered with the Albion 3·85-litre four-cylinder direct injection engine in horizontal form. A nitrided crankshaft, slip-fit renewable liners, automatic fuel injection timing, and built-in centrifugal oil cleaner are amongst the devices which contribute to the low specific weight and fuel consumption. The four-speed gearbox is of unit construction with the engine, having all forward gears in constant mesh with synchromesh on third and fourth.

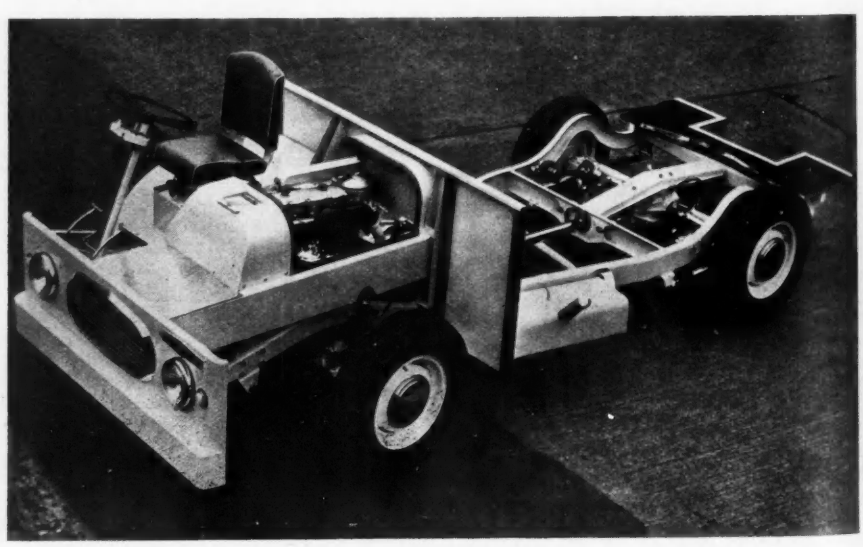


Fig. 6—" Ambulance " chassis

The engine and gearbox are three-point cushion mounted in the chassis frame. The thermostatically controlled flat tube stack radiator is flexibly mounted forward of the front axle, the fan being positively driven from the front end of the crankshaft. Final transmission is by overhead worm drive carried in a single-forged rear axle. The brakes are of the two-leading-shoe design, the foot brake operating hydraulically on all wheels. Rated at a gross vehicle weight of 7 tons, the "Claymore" is suitable for payloads up to 4 tons; it is exhibited with driver's cab having side panels in clear "Perspex" to show the low platform and ease of entrance.

Overseas operators from countries having severe restrictions on axle loadings will be interested in the new "Chieftain" six-wheeled chassis now making its first public appearance. Designed to operate under arduous conditions at a gross weight of 13 tons, it is powered by a 4·88-litre vertical four-cylinder diesel engine of 85 b.h.p. The torque is transmitted to the double-drive rear axles through a constant-mesh five-speed gearbox. The chassis has a wheelbase of 16ft 1in and is suitable for bodywork having an internal length of 21ft 6in. Another four-wheeled "Chieftain" diesel-engined chassis for general haulage work, also displayed at the stand, is fitted with a Duramin cab and platform body, built by the Duramin Engineering Company, Ltd. This vehicle, designed to carry a payload of 6½ tons, weighs unladen less than 3 tons, thus permitting a legal speed of 30 m.p.h., and is likely to interest home transport users.

Scammell Lorries, Ltd., Watford, shows a new 15-ton motive unit and bogie-trailer specifically designed to conform with the proposed new "construction and use regulations" in the confident anticipation that they will shortly become law. The vehicle has a maximum pay-load capacity of 24 tons gross weight and is powered by a six-cylinder Gardener diesel engine, developing 112 h.p. at 1700 r.p.m., with a maximum torque of 358 lb-ft at 1300 r.p.m. The six-speed, constant-mesh gearbox with an oil-pump lubrication has a 6·1 bottom gear and contains a 1·5 : 1 overdrive top gear.

An interesting detail is the rear bogie suspension, which eliminates weight transfer between one axle and the other during braking. It is characterised by the use of Panhard rods to each axle, which take up side loads on links and springs, and by the employment of spherical attachments at the ends of the springs to prevent twisting of the leaves.

At the same stand is also displayed an automatic coupling gear which, originally designed for the three-wheeled Scammell "mechanical horse," has now been widely adopted by leading makers of four-wheeled tractors for gross vehicle weights up to 24 tons. With this new coupling gear a tractor can be coupled to a trailer at any angle up to 90 deg. Coupling or uncoupling is controlled by the driver who need not leave the cab during this operation.

The tractor portion of the coupling gear uses two ramps up which rollers on the turntable of the trailer ride. Positioning of this roller on the ramp is provided by guide rollers contacting the inside of the ramp, and final engagement is secured by a double locking hook engaging on rollers on the underside of the turntable. Cushioning of the impact when coupling is taken by spring-loaded buffers located at the ramps of the tractor. In contrast to previous designs, the trailer is not equipped with the orthodox retractable undercarriage attached to the turntable. Instead pneumatically operated support legs are used which are mechanically locked in both the "up" and "down" position. No wheels are fitted to these legs as it is considered impracticable to move trailers of large size other than by prime movers.

The air supply for operating the legs is automatically connected through the turntable when the trailer is coupled to the tractor and is controlled by a valve in the cab. Similarly an air valve controls the servo which performs the uncoupling operation. The air systems are so arranged that the trailer cannot be uncoupled from the tractor until full pressure of air has been applied to extend the undercarriage legs and, further, a warning light is provided which informs the driver when both undercarriage legs are locked in the extended position.

Another interesting exhibit at the Scammell stand is the latest version of the "Constructor" oilfields truck which is now powered by a modified six-cylinder Rolls-Royce diesel engine developing 185 h.p. at 2100 r.p.m. and having a torque of 505 lb-ft at 1200 r.p.m. It incorporates a built-in oil cooler and the engine cooling system includes a large capacity pressurised radiator to ensure satisfactory operation in tropical countries and under arduous conditions.

Engines and Components

The following comment is concerned with the basic trends which could be discerned in the design and construction of major components of commercial vehicles.

Engines.—Although there are some makes of swirl-chamber diesel engines on the market, amongst them the well-known engines of F. Perkins, Ltd., which are the most popular proprietary power units in light diesel-engined vehicles, the four-stroke direct-injection six-cylinder engine of large capacity and high torque predominates in practically all vehicles of more than about 4 tons payload. Satisfactory in performance, fuel economy, resistance to wear and with good cold starting properties, this type of engine has now reached such a high degree of perfection that modifications have been limited to details. There is, however, some controversy whether or not our present engines are too heavy and bulky, and many prominent designers consider that with a careful selection of transmission ratios and with the possible inclusion of two-speed axles or auxiliary gearboxes, adequate performance could also be obtained from smaller high-speed engines. So far the problem of accommodating more powerful units in chassis, especially in the underfloor position, is not yet topical, but may become so if, with a possible raising of the existing speed limit or for operation abroad, such engines have to be installed, for instance, in long-distance coaches. British manufacturers, anticipating such a development, are apparently not inclined to follow the general Continental practice of raising the engine speed, but seem to prefer a wider application of pressure charging and a more intensive development of the two-stroke engine.

Examples of supercharging are to be seen at various stands. We have already mentioned the 9·8-litre Leyland engine fitted with a radial-flow compressor driven by an exhaust turbine, (shown in Fig. 7), which develops 185 b.h.p., compared with 150 b.h.p. of the normally aspirated engine. Another example of turbo-charging to be found is the new K.R.N.6/8 11·3-litre engine of Thornycroft, which develops 200 b.h.p. at a maximum torque of 625 lb-ft at 1000 r.p.m. The

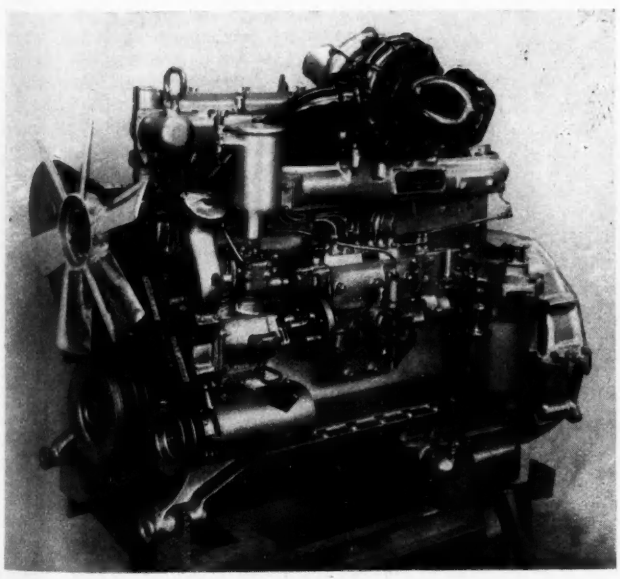


Fig. 7—Turbo-supercharged 9·8-litre oil engine developing 185 b.h.p. at 2000 r.p.m.

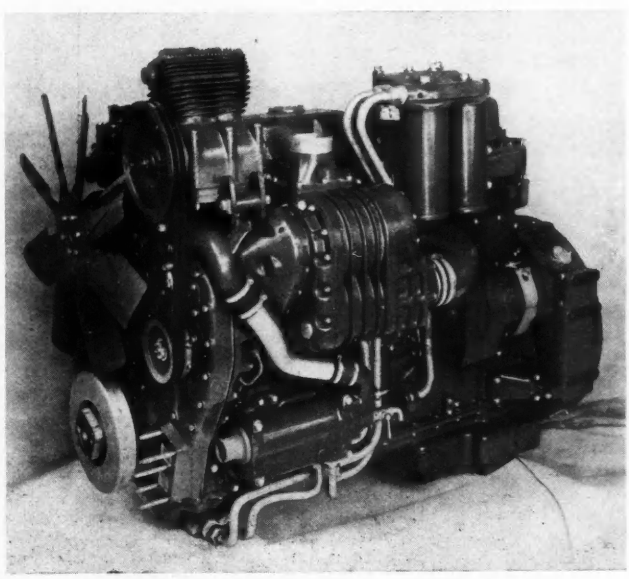


Fig. 8—Six-cylinder, 12·2-litre oil engine developing 250 b.h.p. at 2000 r.p.m.

supercharger is air cooled, weighs only 40 lb. and requires practically no maintenance, it is stated.

Pressure charging by a mechanically driven blower of the Roots principle is employed in the four and six-cylinder diesel engines of Rolls-Royce, Ltd. Both these engines have 5⅛in bore and 6in stroke and are fitted with water-cooled heat exchangers in order to reduce cylinder wear by rapid warming up, and to increase efficiency by maintaining the oil at its most efficient working temperature. The 8·1-litre supercharged four-cylinder engine develops 167 b.h.p. and the six-cylinder 12·2-litre engine, shown in Fig. 8, 250 b.h.p., both at a speed of 2000 r.p.m., i.e. about 25 per cent more than the normally aspirated engine.

In spite of considerable prejudice against the two-stroke engine, there is little doubt that this type of engine, with its total power-to-weight ratio greater than the four-stroke, is gradually coming into its own. We have already mentioned the interesting Commer three-cylinder opposed-piston engine of 3½-litre capacity, which develops 90 b.h.p. at 2400 r.p.m. and has a maximum b.m.e.p. of 94 lb per square inch. The difficulties associated with this design, for instance, the stresses arising from the inertia of the rocker gear and from the unidirectional loading, typical for the two-stroke cycle, have been greatly reduced by clever design. Although the constructional effort might appear rather big for a three-cylinder unit, there is little doubt that the very high thermal and scavenging efficiency of the opposed-piston engine and the absence of a thermally highly stressed cylinder head are very real advantages which can be considered important enough to justify the expense and weight of a more complicated reciprocating gear.

The new three-cylinder two-stroke engine of Turner Manufacturing, Ltd., is basically similar to the two-cylinder model which has been fully described in THE ENGINEER of November 27th, 1953. The three-cylinder unit has a capacity of 2·8 litres and develops 76 b.h.p. at 2800 r.p.m. The b.m.e.p. at maximum speed is 68 lb per square inch and the engine weight with flywheel and housing amounts to 560 lb.

The most powerful British two-stroke engine for road transport is the twelve-cylinder unit of Fodens, Ltd. (Fig. 9), the design of which is based on the well-known Foden marine engine. Like the Foden four and six-cylinder engines, it has a bore of 85mm, a stroke of 120mm and is of the uniflow type with Roots scavenging blower. The complete unit consists of a monobloc casting in aluminium alloy with cast iron wet cylinder liners in two parallel vertical banks. Two crankshafts are each carried in seven white metal bearings and are directly geared together at a phase angle of 30 deg. by a pair of helical gears mounted at the rear end behind the timing gears. A large coupling disc is fitted to one of the contra-rotating shafts to carry the clutch. Owing to the even torque pattern of impulses per revolution of the output shaft a flywheel is not necessary and the disc to carry the clutch is no heavier than sufficient to provide the strength to carry its load.

The mechanical equipment associated with the two banks is identical with that employed on the normal six-cylinder engines ; each bank of cylinders has its own blower, these feeding into spaces in the monobloc casting which form a common air chest for the two banks of cylinders. The exhaust manifold is also common to both banks and lies between them.

The engine has a cylinder capacity of 8·15 litres, develops 252 b.h.p. at 2000 r.p.m. with a torque of 700 lb-ft at 1500 r.p.m.; its total weight is about 2500 lb. Although a power output of 250 b.h.p. is still an exceptional requirement for normal lorries or buses, the engine is a useful addition to the rather limited range of British engines of this size and can be usefully employed for many special-purpose road vehicles and other mobile equipment.

Generally speaking, it can be said that the diesel engine of to-day is not only very economical, but also an exceptionally reliable power unit. The almost universal use of chromium-plated top rings and of heavy-gauge liners of especially hard material, in conjunction with the improvements in the last years of heavy-duty oils, has almost doubled the time of useful performance between major overhauls. For this reason the diesel engine is now being gradually employed in vehicles which only a few years ago were generally fitted with petrol engines ; indeed, there are very few British manufacturers of goods vehicles carrying something between 2 tons and 3 tons who do not offer diesel engines as optional power units. It must be admitted, however, that the initial cost of diesel-engined vehicles is considerably higher than that of petrol-engined ones, mainly for the reason of rather expensive precision-built injection equipment, so that only operators doing more than normal mileages are likely to find the saving in running costs sufficient to warrant the extra initial outlay.

Transmissions.—The development of such transmission units as clutches, universal joints and propeller shafts has remained more or less static. These components are mostly proprietary products, developed to such a degree that modifications are confined to minor details only. There is, however, one item of interest, namely that centrifugally operated friction clutches, of the same design which has been used for many years in a variety of other applications, are now considered sufficiently effective and reliable to be used in place of hydraulic couplings in conjunction with epicyclic gearboxes. Compared to the latter, they have the advantage of eliminating the inevitable small loss in transmission efficiency of the fluid flywheel and therefore the slightly larger amount of fuel consumed with that type of coupling.

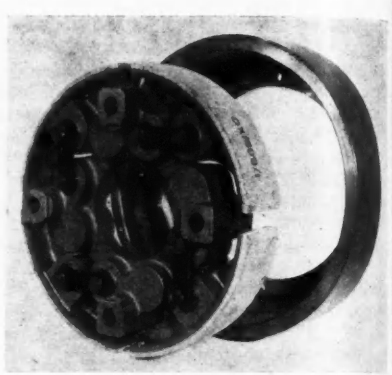


Fig. 10—Centrifugal clutch used as an alternative to fluid transmission

A centrifugal clutch developed by Compression Ignition, Ltd., Twickenham, in conjunction with Daimler, shown in Fig. 10, is available for Daimler passenger transport vehicles as an alternative to the fluid flywheel.

The clutch has a hub on the driving shaft and a drum on the driven member. Trailing links from the hub carry six shoes with friction facings, and the inner pivots of the links are Metalastik rubber-bonded bushes, which are preloaded so that the shoes are retracted from the surface of the drum at idling speed. With increasing engine speed the resistance of the bushes is overcome and contact established between shoes and drum. The outer pivots are also rubber bonded and form a resilient coupling medium between the driving and driven elements of the clutch. A free-wheel device incorporated in the hub is basically similar to that previously used on the original Daimler automatic clutch introduced two years ago.

(To be continued)

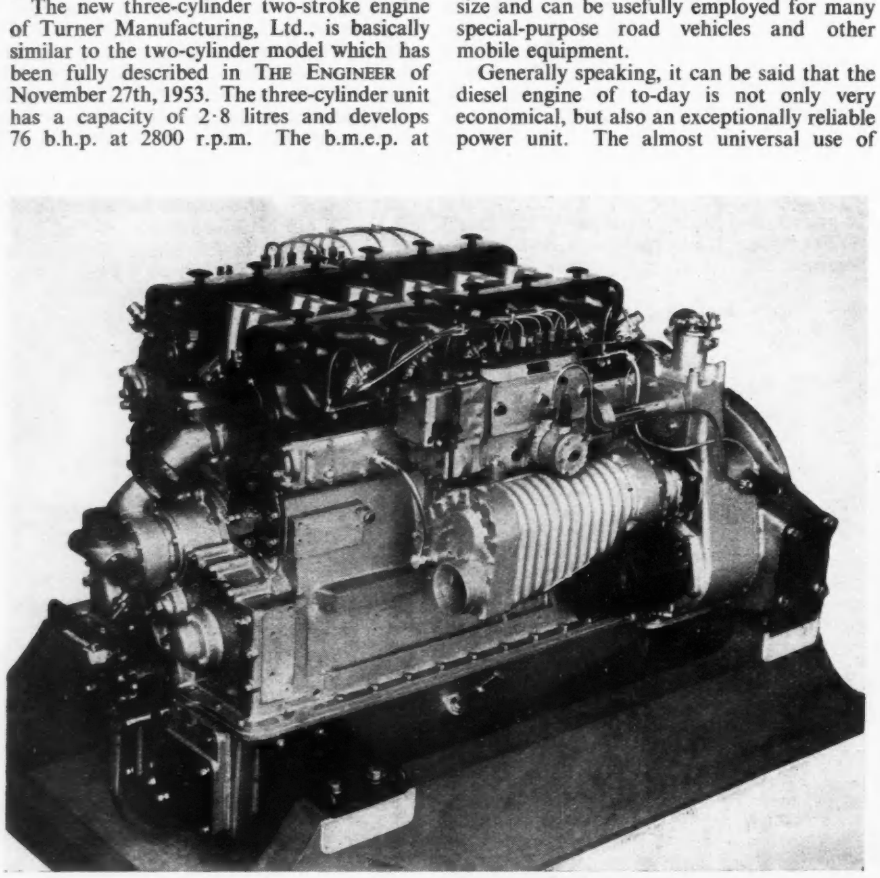


Fig. 9—Twelve-cylinder, two-stroke, 8·15-litre oil engine developing 252 b.h.p. at 2000 r.p.m., and having a torque of 700 lb-ft, at 1500 r.p.m.

Institution of Naval Architects

AUTUMN MEETING

No. 1

THE autumn meeting of the Institution of Naval Architects was held this year at Torquay from Tuesday, September 21st, to Friday, September 24th, during the course of which six technical papers were read in the Electric Hall. The meeting opened on the afternoon of Tuesday, September 21st, with Viscount Runciman, the president, in the chair, and the reading of the following paper.

THE ADMIRALTY EXPERIMENT WORKS, HASLAR

By R. W. L. GAWN, O.B.E., D.Sc., R.C.N.C.

SYNOPSIS

The paper is presented as a tribute to William Froude on the occasion of the unveiling of the memorial to his genius on the site of the original experimental tank at Torquay. His main work was carried out for the Admiralty, and continued at Torquay after his death for a few years until transferred to Haslar nearly seventy years ago. An account of the investigations at Torquay has been given previously and the present paper deals with the work at Haslar.

The scope has widened to meet the exacting requirements of the modern Navy, but the methods rest on the sure foundations laid by William Froude. Formerly the investigations were largely concerned with propulsion, but are now more comprehensive, and seaworthiness, manœuvring, vibration and other qualities are also fully considered. The approach is through model experiments, ship trials, associated theory and research.

The original ship tank at Haslar is now supplemented by one of greater size and carriage speed. There are two cavitation tunnels and other laboratories. Some account is given of the facilities and the requirements which led to their provision together with examples of some of the lessons learnt, including the value of regular tests of standard models.

The programme is closely co-ordinated by the Director of Naval Construction to suit the requirements for designs of H.M ships. Valuable guidance and help is afforded by Sir Geoffrey Taylor, Sir Thomas Havelock and other consultants.

Not the least of our debts to William Froude was the training of his gifted son and successor. A brief appreciation is included of R. E. Froude's achievement at Haslar.

In the course of his presentation of the paper, Dr. Gawn exhibited the first propeller model tested in the admiralty experimental tank, Torquay in 1873. It was made for the model of a cruiser. A film was also shown which depicted some aspects of the activities of the Admiralty Experiment Works at Haslar. It illustrated the preparation of propellers, the testing of a propeller in the cavitation tunnel, anchors and their behaviour in use, turning tests with a self-propelled model in the tank, and the testing of towed models at high speed. The slides shown by Dr. Gawn included a picture of the tank at Torquay, having a carriage suspended from the roof; a squared paper ruling machine made by W. Froude, still in regular use at Haslar, and pictures of R. E. Froude, and William Froude.

DISCUSSION

Sir Maurice E. Denny : By the kindness of the president, I present a brief summary of the work of the experimental tank in Dumbarton, which is the oldest commercial testing tank in the world and antedates Haslar by a few years. This survey covers only the first twenty-five years' work, because by that time John Brown and Co., Ltd., had just built a tank at Clydebank. William Denny, on learning of Froude's early work, visited Torquay and came home fired with the tremendous possibilities of ship model testing. The construction of the tank was immediately begun, and in 1882 it became an effective department of the shipyard.

By modern standards it is small ; the dimensions are : length 300ft, and breadth 22ft 9in, with a normal depth of water of 8ft 6in, but it is doing work of the highest value. Although the first recorded model experiments had been completed in 1883, the tank was for the first four years of little practical value as the work had to start absolutely from scratch and it was essential to collect basic data. A large accumulation of measured mile trials was at hand and therefore the first three to four years were mostly spent in testing models of vessels which had been subjected to such trials. The year 1883 records tests of thirteen models, this figure rising to thirty-six in 1890. Even during the first year of the tank's existence, when no model shaping machine was yet available, the time required for making a 12ft model, testing for resistance and calculating the ship e.h.p., took only six working days—a remarkable performance.

The tank's first superintendent, E. R. Mumford, who had been assistant to William Froude at Torquay, saw the value of systematic model research for future design purposes, and this gave rise to a model series with variations of beam, draught and fineness. In the '80s and early '90s, when paddle vessels remained close rivals of screw ships, the tank was of the greatest value in determining by model tests the correct position of the paddle wheel in relation to the wave formation along the hull, to obtain the correct wheel immersion for the required speed. In some cases wave profiles obtained by model tests were checked on the full-size ship. Systematic model series research, along with the gathering of other test data during these first four years, bore their first practical fruit in 1887, when the Belgian Government asked for tenders for two fast passenger paddle steamers for its Ostend–Dover service. An investigation was carried out on three models with variations for a vessel 300ft by 35ft, the dimensions suggested by the owners, and it appeared that no more than 19½ knots could be guaranteed. At that time, beam was generally regarded as detrimental to speed ; but, encouraged by data gathered from the series of models, new models were put in hand with the beam increased to 38ft, the block cqefficient being correspondingly reduced. As a result, a speed of 20½ knots was offered, and the contract was secured.

It is interesting to note that even in those days, when tank technique was still in its infancy, an attempt at self-propulsion tests was made by fitting paddle wheels to the models with an internal electric drive to assess the effect on power and revolutions per minute of varying the star centre position on a feathering wheel at different float immersions. Doubtless a good deal of interpretation of the results was necessary, but the wheel design in those days must have been of a high standard, when a vessel built in 1890 recorded on trial a peak propulsive efficiency (e.h.p.)/(i.h.p.) of almost 60 per cent at 12 knots and 54 per cent at 16¾ knots. In 1887 the first experiments in waves were carried out in order to measure the increase in resistance, using a crude wave maker consisting of a stout wooden board extending over the whole width of the tank and operated manually by four men to the period of a pendulum.

As early as 1838 the firm became aware that the paint on the under-water hull had much influence on the performance of a ship, and surface friction experiments were carried out with different types of paint, and comparisons established. A few years later the effect of a roughened hull was studied by progressively increasing the grain of the sanded under-water part of the model and taking both resistance and propeller measurements behind the hull. Long before the days of modern wind tunnel tests an attempt was made to record the wind resistance of a fully rigged ship. A model of a passenger ship, complete with all superstructure and rigging was made, placed on a swinging bed at the forward end of the dynamometer carriage and the wind resistance measured at various speeds with the bottom end of the swinging bed coupled to the resistance dynamometer. Although valuable work had been done in connection with paddle steamers, work gradually switched to the problems of screw propulsion, and in the late '80s a propeller dynamometer was available with the propellers driven by an endless cord, and full use was made of it either for individual ship models or for systematic series research. For example, in 1896, several models varying from 12ft to 20ft in length of the same ship were made to measure the resistance of the bossing on a different scale of model, and to obtain the wake and thrust deduction fractions.

Stationary rolling tests were carried out in 1895 on two models to study the effect of bossing and bilge keels on rolling. Each model was allowed to roll freely, the ballast having been adjusted to the correct GM of the ship. The bosses gave an average percentage extinction of 20 to 25 per cent, and the addition of bilge keels raised this figure to about 45 per cent. The effect of shallow water on the performance of a ship was investigated in the early '90s by fitting an adjustable false bottom to the tank. The first experiments were made in connection with a vessel which was required for a very shallow river and tests showed that the speed demanded was impossible and that the deep water resistance was considerably increased in even moderately shallow water. The advent of the turbine steamer increased the scope of the tank work in view of the necessity to test propellers working at very high revolutions.

New demands on the resources of the tank were made when Sir Thomas Lipton commissioned the firm to build a new yacht " Shamrock II." Both owner and builders agreed that in order to have the best possible chance of winning the America Cup in 1901 the new vessel should be tank tested. In designing the new challenger a speed of 11 to 12 knots had to be the target, which meant, for a vessel of 90ft on the nominal water line, a speed/length ratio of 1·2. The tests began with models of " Valkyrie " and " Shamrock I," the last two unsuccessful cup challengers, to find a basis for comparison as a guide for the new vessel, and because changes could be made to those models in a systematic manner so that variations or compromise could be tried out. These tests consisted of ordinary resistance experiments and also measurements of both resistance and side forces with the models at various angles of yaw and heel appropriate to their various racing conditions.

In January, 1905, the superintendent of

the Dumbarton tank, E. R. Mumford, produced a memorandum which stated that flight in air was possible by means of propellers alone, without any supporting plane surfaces. To support his theory he had constructed an exhaustive set of curves of thrust and power for varying diameter and revolutions, both for water and air, and decided to test the theory in practice ; thus Dumbarton became pioneers in helicopter construction. The first machine, of bamboo framework with six propellers, each 25ft in diameter, so geared as to occupy the minimum of space, was fitted with a 40 h.p. engine, which proved unsatisfactory. Later a light metal framework was produced and a new engine procured, but in those days it was difficult to find an engine which would give the necessary power output for any length of time. Tests with a model had shown that the machine had complete stability and would fall gently in the event of the engine failing in mid-air. Calculations also had shown that in flight much less power would be required than would be necessary for leaving the ground vertically. Eventually, trials began, and the machine rose from the ground, but the advent of the first world war stopped further development. Nevertheless, it can be claimed that this machine was the first helicopter ever to leave the ground under its own power.

This morning we have honoured the memory of William Froude, a master mind, and it is fitting that I should pay tribute to the name of William Denny, who was Froude's first disciple.

Sir Victor G. Shepheard : It is appropriate that the opening paper of these meetings should deal with the Admiralty Experiment Works, Haslar. Although the establishment at Haslar was not commenced until some years after the death of William Froude, it was the direct outcome of the pioneer work he did for the Admiralty here in Torquay.

It is sixty-seven years since No. 1 ship tank was completed and in that time the establishment has had three superintendents. Dr. Gawn has told us of the magnificent work done by his predecessors, Mr. R. E. Froude and Mr. M. P. Payne, but I must pay a tribute to the work done by Dr. Gawn, who has been superintendent since 1938, and the bibliography at the end of his paper gives some indication of the contribution he has made to the science of naval architecture. He has told us of the extensions made to the establishment since the days of R. E. Froude and of the great increase in the scope of the investigations, and there is no doubt that the policy of expansion has paid handsome dividends. Additional facilities are in course of construction. No. 2 cavitation tunnel will, I hope, be completed and put into service early next year ; it is considerably larger than the existing tunnel and promises to be an excellent piece of equipment.

A start has already been made on preparing the site for a large manœuvring tank which is essential to solve the problems associated with the sea-worthiness and manœuvrability of both surface warships and submarines. The tank, which will be rectangular, will be equipped with a rotating arm, will be provided with wave generators along two adjacent sides, and should be in full operation in about three years' time. An interesting section of the paper is that which refers to the occasional abnormal changes in the resistance quality of the water in No. 1 ship tank. The physical reason for the change in frictional resistance of the water has never been established definitely, but the fact that it has occurred does emphasise the necessity of our practice of routine checks by means of a standard model. I am surprised that this practice is not universal in towing tanks.

Professor Dr. Ir. W. P. A. van Lammeren : The value of this paper, which is extremely interesting from the point of view of tank testing technique, is increased when it is considered against the background of the history of the Torquay and Haslar tanks, and it demonstrates clearly the greatness of William Froude, the pioneer and founder of model research. The scientific staff of the Netherlands Ship Model Basin and the delegation from the Shipbuilding Society of the Technical University at Delft, which bears the name of the great pioneer, William Froude, and of which I have the privilege of being an honorary member, regard it as a great honour to be able to attend this historic meeting.

It is not only the name of the Shipbuilding Society of the Dutch students which demonstrates the high esteem in which the father of model technique is held, but the fact that the Dutch recognised the importance of his work as early as 1873. This appreciation found its expression in the founding of a towing tank, at that time the second in the world, on the premises of the naval yard at Amsterdam by the naval architect, Tideman. Although, on theoretical grounds, objections may be raised to the method set up by Froude, nevertheless, this method is still employed to-day in practically unaltered form. The recent Seventh International Towing Tank Conference was unable to come to a decision to abandon this method and it will continue to be applied for years to come, with or without a modification of the frictional coefficients.

The experience acquired by the Netherlands Ship Model Basin with regard to the use of Froude's method is very satisfactory, and we see no immediate necessity for introducing changes in the method for routine work. In the paper by myself and my collaborators, to be presented to this meeting, we hope to be able to show that Froude's assumption of equal residual resistances for ship and model holds good at a given choice of extrapolator for the frictional resistance (frictional coefficients) for the ship type concerned. All this goes to prove the brilliance of conception of Froude's method.

With reference to that part of the paper concerning the testing of the standard model, I noticed the great disparities, up to 14 per cent of the frictional resistance, which occur and for which no explanation could be given, and ask the author whether the model was provided with a turbulence stimulator. Before the adoption of stimulators we, too, registered variations up to about 14 per cent in frictional resistance. Even now we have taken to using them we notice that at extreme changes of temperature in the tank in spring and autumn the measuring spots tend to disperse rather strongly. This, in our opinion, may be due to the formation of currents.

For the rest the use of a standard model boat provides in such cases a good means of obtaining an insight into the magnitude of the deviation which may be anticipated.

Professor G. Vedeler : Britain has fostered many great scientists, and if it is possible to rank them I would say that Newton comes first. We all know that Newton's gravitational law has been superseded by Einstein's general law of relativity, and that Newton's concept of light as being of a corpuscular nature has been superseded by the modern concept of light as having both a corpuscular and a wave nature. However, the refinement of Newton's theories is typical of all development of natural science and does not in the least reduce the greatness of Newton. William Froude is in a similar position. His working hypothesis that frictional resistance and residual resistance worked independently of each other and could be kept separate may be said to be superseded by a feeling that there may also be a coupling between the two types of resistance and that this may explain some discrepancies which have not been fully explored yet. The formulation of the eventual coupling has not been made yet, but we feel that we shall, under certain circumstances, have to introduce a refinement to the Froude theory. I sympathise with you Britishers in that you do not like to have Froude's great name in connection with skin friction substituted by any of the many names mentioned in present-day discussions and none of whose lines have yet been proved to have a basic foundation. Whatever may be the name of the future frictional line, it can never in the least reduce the admiration we have for Froude and the greatness of his name and his work.

Dr. Gawn's paper to-day is not only a tribute to William Froude, but it also shows that all the superintendents of the Admiralty Experiment Works at Haslar have always kept their equipment at maximum efficiency. With the equipment now available at Haslar and the collaboration there with some of the best theoretical brains of the world, we shall receive not only excellent reports from the present superintendent, but also papers of lasting value.

Having been the chairman of the international committee on seagoing qualities during the first three years of its existence, I have been especially interested in the information given in the paper on the equipment and work done in connection with sea-worthiness. The committee on sea-going qualities at the international conference in Göteborg last month reported upon the results of comparative tests of models in waves, made by ten different tanks. The results from nine of the tanks agreed in the respect that they all showed a maximum of resistance and a maximum of pitch and heave at a tuning factor of unity or slightly above. The nine tanks all used a gravity type of towing equipment which allowed the models to surge, while the tenth tank, which used a different type of attachment to the carriage, obtained results which differed from those of the other tanks. In discussing this report Dr. Gawn pointed out that the results from the nine tanks were in disagreement with theory, which requires maximum pitch and heave to occur at a tuning factor below unity, and that all tests in waves made at Haslar, with the model fixed to the carriage, are in agreement with theory in this respect.

At the conference we were given the results of measurements made at sea on the Japanese S.S. " Nissey Maru " and the tests of its model in a Japanese tank. This ship has a block coefficient of 0·73. Its model was tested in the fully loaded and in the ballast conditions. Curves based on the figures given in the Japanese report show a result similar to those of the comparative tests from the nine tanks already mentioned, viz. that the maximum resistance for all speeds and both conditions tested occurs at a tuning factor slightly above unity. A gravity type towing equipment was used. The discrepancy with theory when the model is allowed to surge suggests the possibility of a coupling between the oscillating surging motion and pitch and heave which may cause the shift of the maximum point to a higher tuning factor than is expected from theory when surge is left out of consideration. I mention this because it might be a problem worth studying at Haslar.

Mr. W. C. S. Wigley : Dr. Gawn has now

given us two very interesting papers, in 1941 and this year, on the work, generally speaking of William Froude and his successors. May I put before you a mathematician's view of William Froude's discoveries. It seems to me that William Froude is praised largely for what he did not do and is not praised for what he did. Some 200 years ago the Frenchman D'Alembert discovered the paradox that a body moving in a perfect fluid has no resistance. The result was that classical people said, " Oh, well, theoretical hydrodynamics giving a result like that is of no use practically," and it was developed as a sort of mathematician's heaven of complicated theories, mathematical functions, and so on, so that the science of hydrodynamics on the mathematical side did not have any practical application for 100 years or more after D'Alembert's discovery. In 1830, however, Navier wrote down the equations for a viscous fluid, although he could not solve them—and they have not been solved to-day.

We now know that the resistance of a body in a viscous fluid must be a function of the Froude number and the Reynolds number. That was known at the time Froude designed his tank. He was not a mathematician, but he was that very rare type of engineer who had a mathematical mind, so that he could understand what the complicated mathematics meant and could turn it to practical use. That he did. He knew the mathematicians had proved that the resistance of a body must be a function of the Froude number and the Reynolds number and he said let us assume that the resistance consists of two parts, one depending on the Froude number and the other on the Reynolds number. So far as I am aware, nobody thought of doing that before Froude, and that is the thing for which Froude is not praised.

Sir Westcott S. Abell : William Froude laid down in a very short time a programme of work, and it took his son, R. E. Froude, twenty-five years to deal with it. I have put on record a story of William Froude and his life, but I have never yet seen a detailed account of the work of R. E. Froude, which I think ought to be provided by this Institution.

(*To be continued*)

Book of Reference

The Ironmonger Pocket Book of Tables. London : *The Ironmonger*, 28, Essex Street, Strand, W.C.2. Price 3s. 6d.—The new edition—the eighth—of *The Ironmonger Pocket Book of Tables* has been fully revised. It is more comprehensive than any of its predecessors, for many new tables have been added, others expanded, and those based on British Standards brought up to date according to the latest specifications. In its fifty-six pages over a hundred tables of data are given, all concisely set forth and fully indexed. Among the contents are data on iron, steel and non-ferrous metal sheets, sections, tubes and wire ; gauges ; bolts and nuts, nails, rivets, screws and washers ; screw threads ; asbestos cement goods ; h.w. supply, cisterns, tanks and cylinders ; r.w. goods ; power transmission ; sanitary ware ; wallpaper and paint.

CORROSION MEETING, 1954/DECHEMA ANNUAL MEETING, 1954.—The Corrosion Meeting, 1954, and the Dechema Annual Meeting, 1954, will be held simultaneously and with the participation of the European Federation of Chemical Engineering, from November 11th to 13th, in Frankfurt a.M. The meetings are sponsored by the Arbeitsgemeinschaft Korrosion (Corrosion Group) which consists of eight German technical and scientific societies. Many important advances have been made since the last meeting was held in 1943. " The Nature and Causes of Corrosion " is the main theme of ten papers to be read on November 11th and " Processes for the Prevention of Corrosion " will be the subject for ten other papers to be presented on November 12th. The lectures will be given by well-known scientists and industrialists and an opportunity will be provided of visiting a number of industrial works in the Frankfurt district on November 13th. The meetings are being arranged by Dechema Deutsche Gesellschaft fuer chemisches Apparatewesen, Frankfurt a.M.-West 13, who will send invitations or further information on request.

Hydro-Electric Power Station at Niagara Falls

The Hydro-Electric Power Commission of Ontario recently inaugurated its Sir Adam Beck—Niagara No. 2 power station, which exploits the waters of the Niagara River at the site of the falls. The power station is exceeded in size by few other hydro-electric installations ; it includes a pumped storage scheme. A brief description of the power station and diversion works and of the Niagara diversion treaty is given here.

ON August 30th, Her Royal Highness the Duchess of Kent opened the new power station which has been built by the Hydro-Electric Power Commission of Ontario on the Niagara River. This station is the largest of the Commission's undertakings, and when completed it will have an installed capacity of 1370MW ; however, the great size of the power station is not by any means its only claim to the interest of the engineer, for various technical problems of unusual difficulty had to be solved in its design and construction. The station is known as the Sir Adam Beck—Niagara No. 2 generating station. The No. 1 station, close by, was completed in 1921 ; it has an installed capacity of nearly 400MW and for many years was the world's most powerful hydro-electric station. Both stations are named after the founder of the power commission, Sir Adam Beck. The layout of the new scheme is shown in Fig. 2, but before describing it any further a few words should be said on the treaty governing the use of the river waters at this site.

THE NIAGARA DIVERSION TREATY

Niagara Falls are exceeded in height by several other natural cataracts, but the quantity of water flowing over the falls far exceeds the quantities experienced elsewhere, and in this respect the falls are unique. With this vast flow, and with the regulating effect of Lake Erie a few miles upstream, the site must also be unique in the opportunity it offers to the hydro-electric engineer.

Apart from the new power station, there are six earlier hydro-electric stations close to the falls, which are indicated in Fig. 2. A comprehensive development of this vast natural source of power could not have been contemplated until the electrical power demands of the neighbouring countryside had become large, a stage of development which was reached in the post-war expansion programmes of recent years. But there were other important problems to be solved before large-scale construction could be started, and in 1950 the Niagara diversion treaty was signed by Canada and the United States, so that development on a comprehensive scale could be started.

The twofold aim of the treaty was to preserve the scenic beauty of Niagara Falls, and at the same time permit the maximum compatible use of the river for hydro-electric power production. It was agreed that during the summer season from April 1st to September 30th, a minimum flow of 100,000 cusecs would be maintained over the falls during the day (from 8 a.m. to 10 p.m., with a reduction of two hours in the last fortnight), and the flow in excess of that amount used for power generation. At all other times a flow of 50,000 cusecs would be maintained down the falls, except at certain times during the winter when it would be necessary to flush ice out of the gorge below the falls. Half of the water available for power generation would be used by Canada, and half by the United States, with an additional 5000 cusecs allowed to Canada that is diverted from the Hudson Bay catchment area.

The treaty also stipulates that remedial works will be built to distribute the flow of water passing over the falls more evenly. In the natural condition, 90 per cent of the river flow passes down the Horseshoe Falls, and only

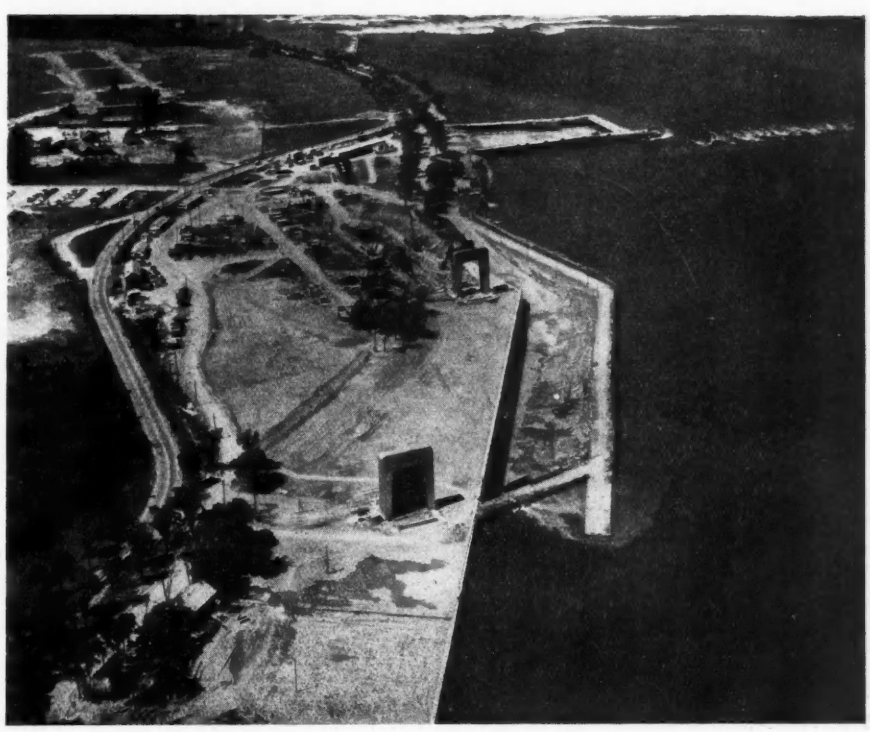
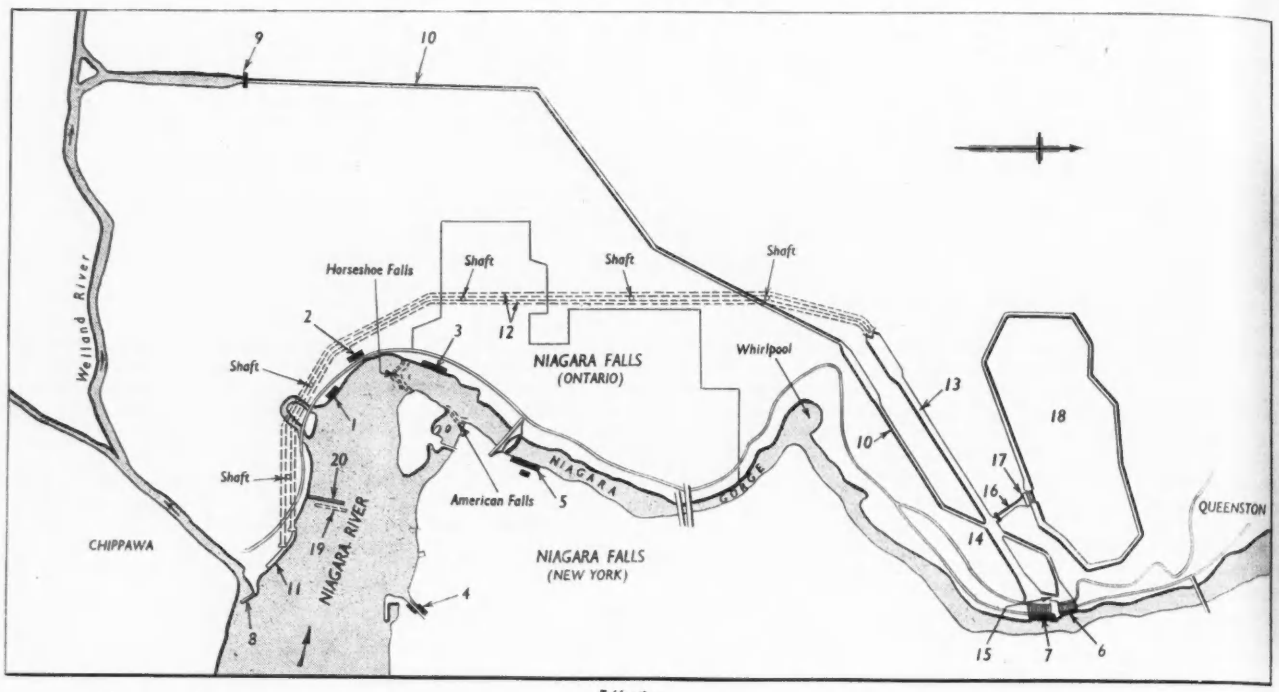


Fig. 1—Intake works for the Sir Adam Beck-Niagara No. 2 power station. The cofferdam is still in position protecting the second gathering tube, and the tunnel transition is under construction behind the second gate tower.



Power Stations
1—Toronto power generating station.
2—Canadian Niagara generating station.
3—Ontario power generating station.
4—Adams generating station.
5—Schoelkopf generating station.
6—Sir Adam Beck-Niagara No. 1 generating station.
7—Sir Adam Beck-Niagara No. 2 generating station.

Diversion Works for Sir Adam Beck-Niagara No. 1 Station
8—Intake.
9—Control gate.
10—Power canal.

Diversion Works for Sir Adam Beck-Niagara No. 2 Station
11—Twin intake tubes and control gates.
12—Twin 45ft diameter tunnels.
13—Power canal.
14—Intersection of old and new canals.
15—Combined forebay.
16—Pumped storage canal.
17—Pumped storage power station.
18—Pumped storage reservoir.

Niagara Falls Remedial Works
19—Submerged weir.
20—Control structure.

Fig. 2—Hydro-electric power generation at Niagara Falls. The diversion works of the Sir Adam Beck-Niagara No. 2 power station are shown in plan and cross section

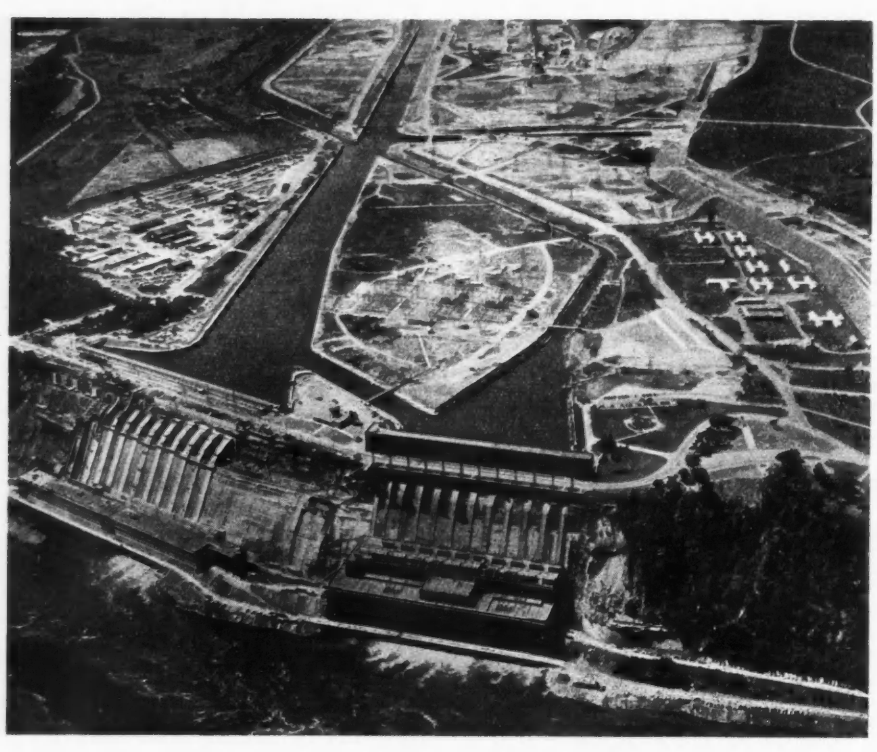


Fig. 3—The Sir Adam Beck-Niagara generating stations. The old No. 1 station is on the right, and the layout of the old and new diversion canals and forebays is clearly shown

10 per cent down the American Falls ; of the former amount, 65 per cent passes over the middle third of the cataract, which consequently has been eroding at a rapid rate. Remedial works have therefore been planned to give a more even distribution of flow, thus avoiding the bare flanks at the falls characteristic of low water periods, and reducing erosion. The scenic attraction of the falls will therefore be unimpaired, although less water will pass over them. These remedial works alone are no mean engineering task. The first of them—a submerged weir on the Canadian side, just below the intakes of the new power station—was built in 1942–44. A control structure 1550ft in length and with thirteen sluice gates is at present being built just downstream from the weir to give further control of the flow. Other works involve excavation and fill along various parts of the Horseshoe Falls crest line, which is 2600ft long, to give a more even distribution of flow. These works were designed from hydraulic model experiments, the models also being utilised to design the new intake works for the power station.

At present the United States has not developed its share of the water power available at Niagara, and so the large Canadian power stations are able to operate more or less continuously at full power. Later on, when the American side is exploited, the older Canadian stations shown in Fig. 2 will be closed down, leaving the Sir Adam Beck Nos. 1 and 2 stations in operation. On the last occasion when the new project was mentioned in these columns (THE ENGINEER, January 30, 1953) it was stated that the installed capacity of the Sir Adam Beck No. 2 station would be 900MW in twelve sets. Since then the design has been modified and these twelve units now comprise the first stage works, to be completed as follows :—Five sets in service this

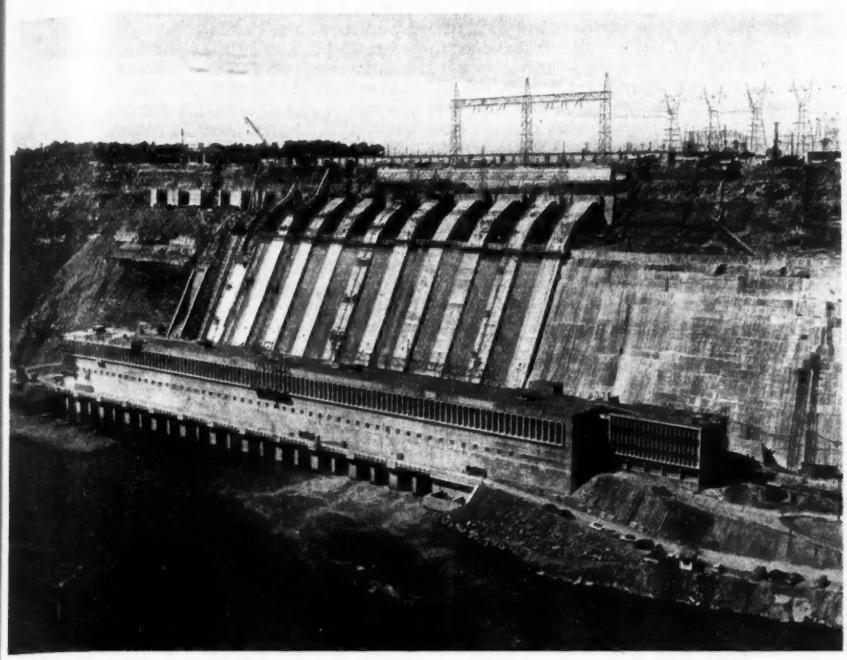


Fig. 4—The new power station at Niagara Falls. The station will ultimately have sixteen 75MW turbo-alternator sets, and is associated with a 170MW pumped storage scheme

year, six sets in 1955 and the last set in 1956. A pumped storage scheme totalling 170MW has been added to this stage, for operation by 1957. The second stage comprises four additional 75MW sets to be installed subsequently, as they are required, to give the scheme its total capacity of 1370MW ; part of the canal will have to be widened, and the forebay extended when these sets are installed.

Intake and Diversion Works

The general layout of the diversion works associated with the Sir Adam Beck—Niagara No. 2 station will be readily apparent from Fig. 2. The station operates under a rated head of 292ft (the falls are 160ft in height, and the total fall of the Niagara River between Lakes Erie and Ontario is 326ft).

The main problems in designing the intake works were to avoid turbulence, and to provide intakes that would not be choked by ice in the winter. A novel solution was evolved in the form of two " gathering tubes," each 500ft long and submerged close to the shore, in a position approximately parallel to the direction of the stream, at a point about 2 miles upstream from the falls. These gathering tubes are of reinforced concrete, with a series of openings along their lengths. Each tube supplies one of the twin diversion tunnels. The river has been dredged for a distance of 400ft from the gathering tubes, to allow the full capacity to be diverted, and also to give sufficient current to keep the intakes clear of ice. The space between the tubes and the old shore line has been filled in, and the shore realigned. The two intake structures were built inside timber crib and steel sheet pile and earthen cofferdams (1100ft of cribwork and 400ft of earth bank altogether), which in themselves represented no mean engineering achievement considering the speed of the river at this point.

Just below each intake, there is a control gate with a 45ft clear opening, 58ft high, and weighing 200 tons. The control towers for these gates are 77ft in height, and are clad with aluminium sheeting. Fig. 1 shows these two control gate towers ; in the foreground is the completed tower and intake for the first tunnel, with construction of the second intake in progress further back, where the cofferdam is still in position. The headworks of the first shaft for tunnel construction can be seen in the left background, and the cofferdam for the control structure for the remedial works at the falls in the right background.

The two tunnels of the scheme each have a finished diameter of 45ft, with a 3ft lining of reinforced concrete. The cross section in Fig. 2 shows the rather unusual layout of the tunnels which, as may be observed, are subjected to a head of about 300ft for a considerable length. The tunnels pass under the city of Niagara Falls and were presumably taken to the depth shown so as to provide an adequate rock cover for tunnelling without any possibility of surface disturbances. The tunnels are each 5½ miles in length, and emerge into an open channel when the built-up area has been passed. The hydraulic capacity of these twin intake works and tunnels is about 20,000 cusecs for each of them.

Five shafts were sunk for the construction of the tunnels, centrally situated so that they could be used for work on both the tunnels. Various spoil tips, which will be graded and sown, have been sited on the outskirts of the city. The two tunnels are 250ft apart, measured centre to centre. The 51ft diameter excavation for each tunnel was done in two stages, the upper half of the tunnel being formed first. Conventional surface excavators and 15-ton trucks were employed for this work, the tunnel excavation totalling about 4,000,000 cubic yards.

The downstream portals of the two tunnels lead into a canal which traverses the last 2¼ miles to the power station forebay. It is designed for the full capacity of 40,000 cusecs, with average depth and width of 70ft and 200ft respectively, and is unlined for most of its length, where it is cut from the rock, but a concrete lining has been built close to the tunnel portals where a deep deposit of moraine was experienced. About 8,250,000 cubic yards of excavation was necessary to build the canal. During its course the canal cuts across the canal supplying the No. 1 station, and at the downstream end the two forebays are connected together. The design of the canal crossing presented an unusual hydraulic problem ; model tests were employed to verify the design and to examine other difficult hydraulic problems, such as the intake and adjacent tunnel design, the tunnel exit, and the shared forebay.

Power Station and Pumped Storage Scheme

A general idea of the power station layout is given by Figs. 3 and 4. Fig. 3 shows the No. 1 station to the right, and the common forebay and canal intersection mentioned above may be observed, as may the switching yard on the island formed by the canals. Control of both stations is unified in the building on the right of the new power station.

The No. 2 power station is 50ft in height, 63ft wide and 1150ft long, with an 85ft depth of substructure. Eleven penstocks are shown either completed or under construction in the illustrations, corresponding to the 1955 programme, which, it may be recalled, includes completion of eleven of the first twelve 75MW sets. Each penstock comprises a steel pipe 19ft in diameter and 492ft long, encased in reinforced concrete.

A corner of the pumped storage reservoir of the scheme may be seen under construction in the top right-hand corner of Fig. 3, where a rock-fill embankment is being built just behind the H-shaped buildings of one of the construction camps. The pumped storage scheme is clearly shown in the plan, Fig. 2. It will comprise four pumping sets totalling 170MW, with which the reservoir, which has a total storage capacity of almost 15,000 acre-feet and extends over about 700 acres, will be replenished at times of low load, thus enabling extra power to be generated at peak periods. The canal of the pumped storage scheme is 1400ft long. It would appear from the flow figures given earlier that the reservoir could be replenished each night during the summer period, if the power demands during the day were high enough to warrant it.

The Hydro-Electric Power Commission of Ontario started work on the entire scheme in December, 1950, and about 7000 men were employed at the peak period. Its cost is given as almost 344 million dollars. The first tunnel was filled last June, but the first set in the power station has been in operation since last April, the forebay having been supplied from the diversion works of the No. 1 station until the tunnel had been completed.

Institution of Naval Architects at Torquay

Tuesday, September 21st, was the opening day of the autumn meeting of the Institution of Naval Architects, which this year was held at Torquay, this venue being chosen for the particular purpose of honouring the memory of William Froude, who was the pioneer and founder of ship model research. The meeting was attended by about one hundred and thirty members from the United States, Norway, Sweden, Denmark, Holland and Belgium, and their ladies and several representatives of the Scheepsbouwkundig Gezelschap William Froude.

The first official event of the Torquay meeting took place at 11.30 a.m. on the morning of Tuesday, and was the ceremony of unveiling a memorial plaque to William Froude. Those gathered together in a Devon lane to witness the ceremony included, in addition to the members of the Institution, the Mayor and Mayoress of Torquay, Councillor W. H. White and Mrs. White, and other civic representatives and also three grandchildren of William Froude, namely, Miss Mary Froude, Miss Beatrice Froude, and Mr. W. Froude. The president of the Institution, Viscount Runciman of Doxford, before performing the unveiling ceremony, gave a brief address, during the course of which he mentioned that William Froude was a modest genius and rather overshadowed by his two brothers. Even to-day his name was little known outside the circle of those who designed and built ships, but, continued Lord Runciman, the effect of his pioneer work of testing models of ships in a tank as a basis for the design of ship hulls, was the major factor in the progressive improvement in the economy of hull forms and so benefited all those who used, in any way, anything which was transported by sea.

The president recalled that it was from a suggestion made at the sixth international conference of tank superintendents that the memorial came into being, a memorial which was close to the place where Froude built the first ship model experimental tank in the world, eighty-four years ago. There was considerable scepticism from professional sources as to the value of the possible results to be obtained from model experiments, but fortunately the Admiralty were convinced and provided some financial backing for the work. Lord Runciman went on to mention that to commemorate Froude's work the Institution had in course of preparation a book containing all his technical

papers. He then unveiled the memorial plaque, a photograph of which is reproduced. The memorial consists of a wall of local red sandstone, set back from the road in Seaway Lane, supporting a bronze plaque carrying the head of William Froude with the following inscription :—"William Froude, M.A., LL.D., F.R.S., 1810–1879. William Froude was born in 1810 at Dartington, Devon, and lived at Chelston Cross from 1867 until his death in 1879. His outstanding contributions to the science of naval architecture brought him worldwide renown. He was the pioneer of ship model research, and in 1872 built the first experiment tank in the world on this site for the Admiralty, for whom his main work was carried out. This memorial was erected in 1954 by naval architects of many countries as a grateful tribute to his genius."

Professor H. F. Nordstrom also addressed the gathering and said that the International Conference on Ship Hydrodynamics, which he was representing, could be regarded as an association of William Froude's successors. To-day, work continues to be based upon the principles laid down by Froude, and the professor maintained that the progress of humanity had been greatly advanced by Froude's achievement and that the importance of the experimental tank work

Memorial Plaque to William Froude

carried out and based on Froude's principles was recognised universally. Professor Nordstrom concluded by reading a telegram from Professor Hogner, the Director of the Ship Testing Laboratory at Stockholm, which read as follows :—"On the occasion of the commemoration of William Froude and his work the Ship Testing Laboratory of the Royal Institute of Technology, Stockholm, renders homage to his memory." Wreaths and chaplets were then laid at the foot of the memorial plaque by Lord Runciman on behalf of the Institution of Naval Architects, by Professor Nordstrom on behalf of the International Conference on Ship Hydrodynamics, and by His Worship the Mayor of Torquay on behalf of distinguished residents and the aldermen and burgesses of the Borough. Upon the conclusion of the ceremony those present took the opportunity to visit Froude's home at Chelston Cross before attending the official luncheon held at the Grand Hotel. During the afternoon papers were read at the Electric Hall and afterwards the members and their ladies took tea in the Town Hall as guests of the mayor of Torquay.

Further papers were presented on Wednesday morning and in the afternoon the delegates made the journey, by motor coach, to Dartington Parsonage, the birthplace of William Froude, and to Dartington Hall. This is now a trust, which owns about 3000 acres of land and consists of two companies, to look after the commercial enterprises, which include farms, a sawmill, a textile mill, and woodlands, and endowed departments to carry out the purposes of the trust in education and research. The manor of Dartington dates back to A.D. 833, and passed into the possession of several families before coming into the ownership of the Champernowne family in the reign of Henry VIII. It remained in their possession for three hundred years until 1925, when it was bought by the present owners. On the evening of the same day all the delegates attended a theatrical performance at the invitation of the mayor of Torquay.

On the morning of the following day, Thursday, September 23rd, the members journeyed by motor coach to Plymouth to pay a visit to the Royal Naval Engineering College at Manadon. Here they were received by the commanding officer, Captain C. Gatey, R.N., and conducted over the establishment by members of the staff. Although the tour was only of short duration, the arrangements were such that members were able to see a great deal of the equipment in the workshops and the laboratories and to form an overall picture of the training programme of future engineer officers of the Royal Navy. After taking lunch in the mess at Keyham as guests of the college, the members went on to visit the Royal Naval Dockyard, Devonport. During the course of a short tour of the dockyard a visit was paid to an "A" class submarine undergoing a refit and also the aircraft carrier "Eagle," which was also undergoing a considerable amount of reconstruction to meet the latest service requirements. Later the members and their ladies were entertained to tea by the Commander-in-Chief, Devonport, Admiral Sir Alexander Madden, at Admiralty House, Mount Wise

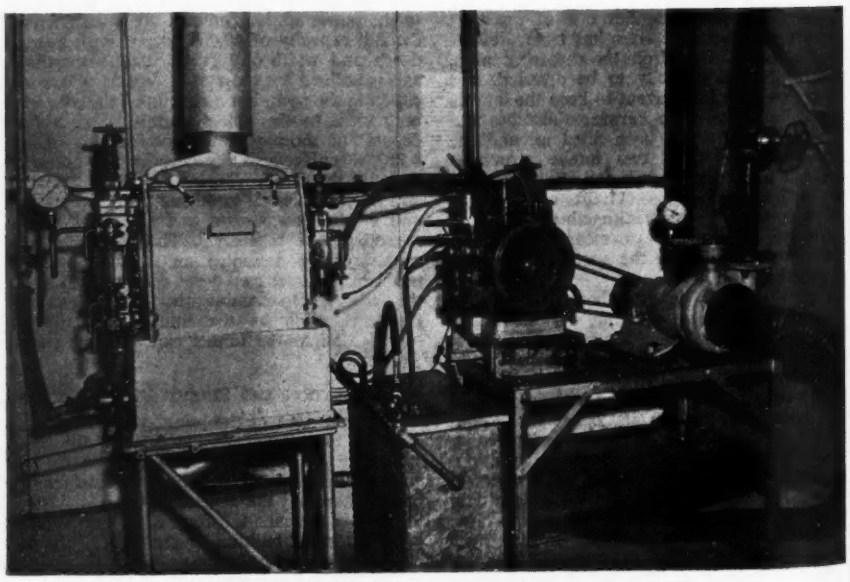
Portable Steam Engine and Boiler

In many areas of the world great benefits would accrue from the increased application of mechanical power to agriculture and existing small-scale industries. Many of these "underdeveloped" countries, however, either lack the capital resources required for large schemes of electrification or cannot afford to base their economy on hydro-electricity which may fail under prolonged drought, as has happened in India, or on any kind of imported fuel, from which they may be cut off at times of economic or political crises. When the problem was under discussion some years ago, it was felt that the best approach would be to develop a small steam unit, which could be fired with locally obtainable combustible waste, or even with crops specially grown for the purpose. In the N.P.L. report on "The Utilisation of Solar Energy" (The Engineer, November 21, 1952) this last possibility was considered feasible and, in fact, from a purely thermodynamic viewpoint, superior to the use of draught animals such as bullocks.

A research and development contract for such a unit, including furnace, boiler and engine, was placed by the National Research Development Corporation with Ricardo and Co. (1927), Ltd., and after trials of the first engine a number of improved prototypes were built by the Corporation and tested at the Sondes Place Research Institute at Dorking. These tests were under the supervision of Brigadier M. H. Cox, an expert on Eastern countries, and were done under simulated field conditions. They included wear and corrosion tests, solid fuel tests with different types of furnace, and overload and continuous running tests.

With steam at 150 lb per square inch the present engine develops 2½ h.p. (3½ h.p. intermittently) at a governed speed of 1250 r.p.m. for a steam consumption of 30 lb per hour; a scaled-up 5 h.p. version is contemplated. Its possibilities were well illustrated in a recent demonstration, when it was shown, as illustrated below, driving a 5000-gallons per hour centrifugal pump; driving a flour mill; operating the heating and air circulating equipment of a timber seasoning plant; powering a small rural workshop; generating electricity for a rural hospital; and supplying electricity and hot water for a tropical bungalow; and finally, as a trailer-mounted unit, operating a sprinkler irrigation system or, alternatively, driving a chain saw.

The engine and boiler are illustrated on page 455. Crankcase 1, cylinder block 2, and cylinder head 3 are made of light alloy. Crankshaft 4 carries a flywheel at one end, and a vee rope pulley at the other. The two pistons of 2¼in bore by 2¼in stroke are set at 180 deg. and work on the uniflow principle. A camshaft driven by a roller chain from sprocket 14 operates the two inlet valves 10 and the variable cut-off valve 6. The chain

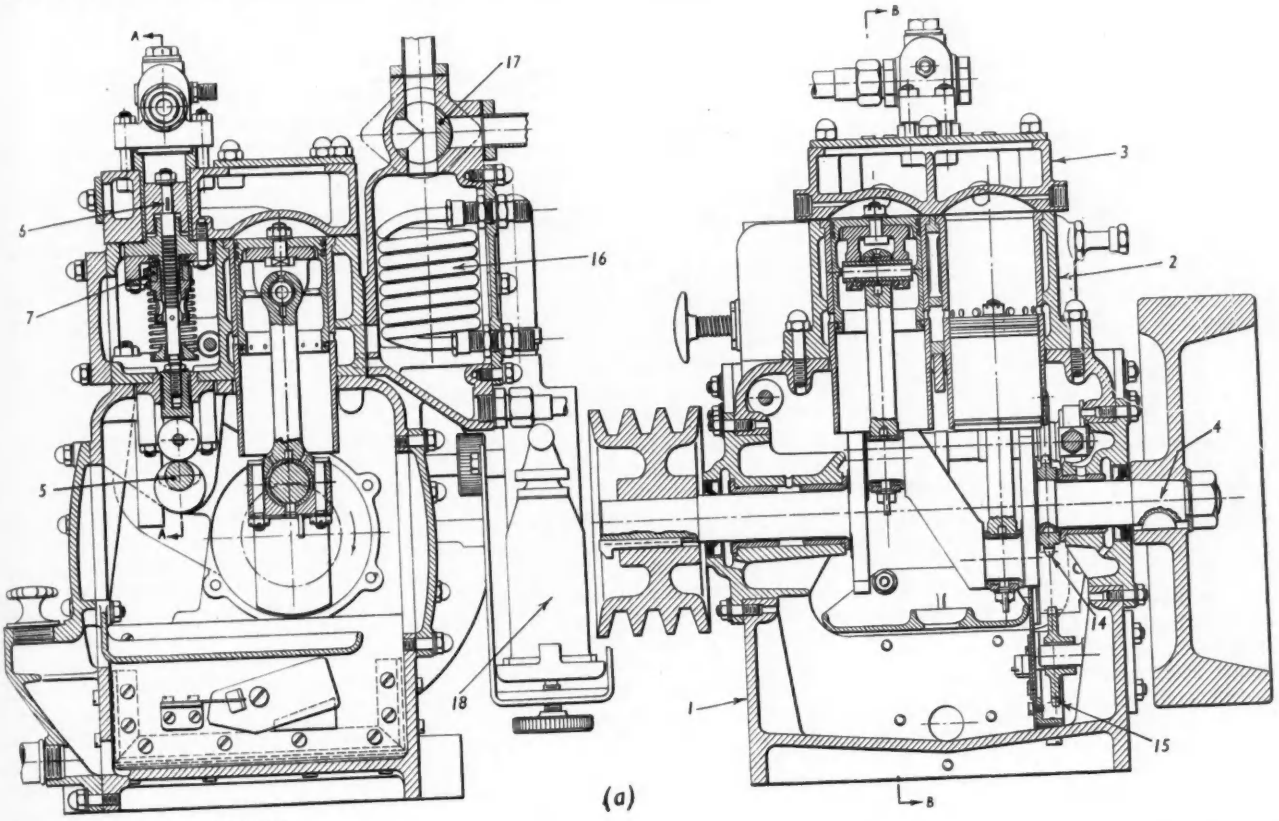


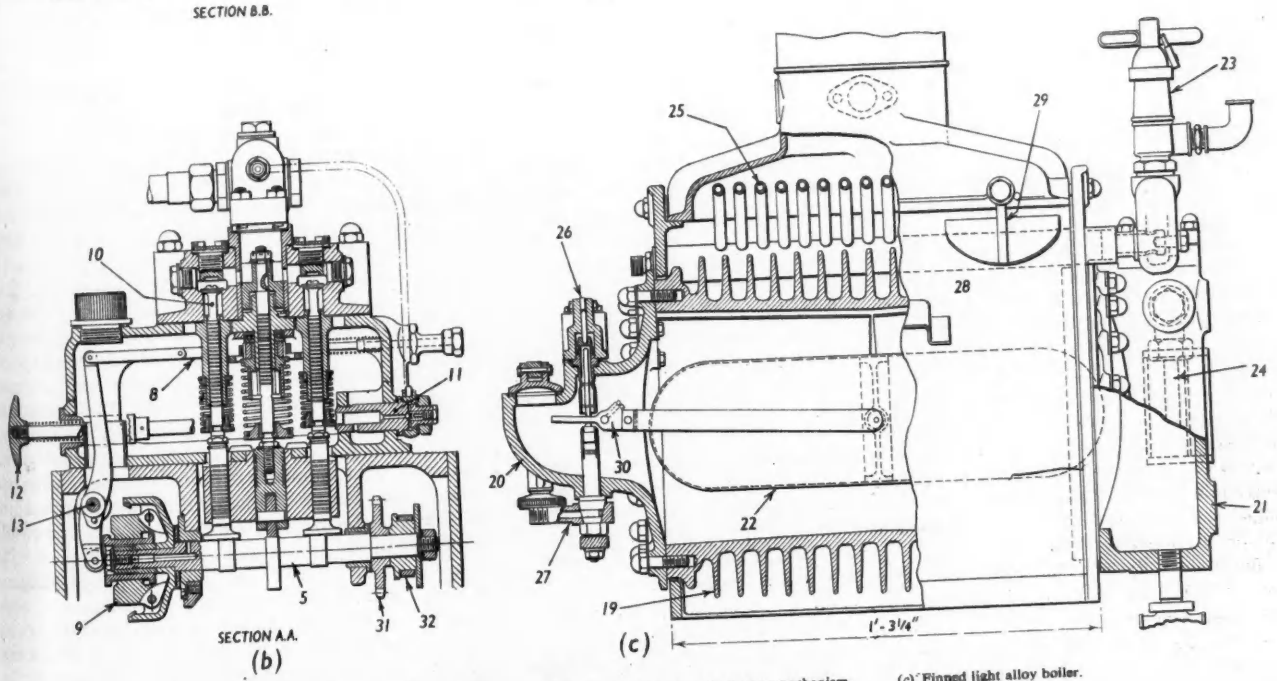
Steam engine and boiler set up to drive medium head pump

may be tensioned by the eccentrically mounted sprocket 15. Valve 6 admits inlet steam through helical ports, the cut-off being varied by turning the valve by means of pinion 7 and rack 8. The action of the governor 9 is transmitted to the rack through a linkage, speed selection being by setting by hand the eccentric fulcrum 13. At the end of the camshaft opposite to the governor can be seen the eccentric which drives the feed pump. A small hand-operated pump 11, 12, supplies lubricating oil to the valves through the dotted pipe. All other lubrication is by splash action; the deep sump allowing any condense water to collect at the bottom, where it can be drained off. Feed water is passed through filter 18 and coil 16, where it is heated by the exhaust steam. A valve 17 in the exhaust pipe allows the steam to be diverted to the boiler to provide induced draught.

The furnace (not shown in the diagram) is of simple design and is preferably made with a grate area to suit the fuel which will be used; a smaller area being desirable for coal or wood, and a larger one for agricultural waste materials. Immediately above the furnace is the boiler, consisting of a finned light alloy shell 19 with end pieces 20 and 21. It contains the float 22 which controls the water inlet valve 27 and low-level safety device 26. The fulcrum pin 30 is taken out of the boiler through a gland and, if it should stick, may be freed by moving it axially to and fro. Dry steam is obtained by passing it through the superheater 25, at one end of which is mounted the safety valve 23.

There is a sight glass (24) and a connection for a pressure gauge is provided. The sides of the boiler are shrouded by two covers 28 having hollow walls filled with insulating material. These covers are retained at the bottom by grooves in the frame and at the top by catches 29, bolted to the cylinder head and may easily be removed for inspection and cleaning of the boiler shell. A connection is provided in end piece 21 for the blowing down of deposits. Running tests covering several hundred hours have produced only negligible wear of the engine, with an oil consumption at the end of the test of 0·003 to 0·005 pint per horsepower per hour.





(a) Sectional elevation and end view of engine. (b) View of valve gear and governor mechanism. (c) Finned light alloy boiler.

Sectional views of engine and boiler

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SPREADING THE SEED

The setting up at Harwell of a Reactor School, as announced on another page of this issue, is a development very heartily to be welcomed. The main objective of that school, as Sir John Cockcroft expressed it at the opening ceremony last Monday, " is to enable British industry to design and build economic power units as early as possible since there is a general belief that we will need quite sizeable additions to electrical power output from nuclear energy in the nineteen-sixties." So far the heat and burden of the day in manufacturing and helping to design existing nuclear plants and the first two nuclear power stations have been borne by very few companies. Those companies stand at present alone in having experience of the novel engineering problems set in the design of nuclear power stations. Great credit is due to them for their initiative in accepting contracts at a time when their design staffs were already overloaded with more familiar work, the profitability of which was much more assured. Their reward begins now to be actively discernible. Those firms have acquired a lead over others in that they already have staffs familiar with the engineering problems of generating nuclear power, staffs already capable of assessing critically the merits of existing plants and of devising improved designs. Firms that were not in at the beginning have all this familiarity yet to gain. Nor can they be certain at the present stage that any immediate practical application of the knowledge staff members gain at Harwell will become available to them.

But in heartily welcoming this new venture which was, indeed, foreshadowed at the time the Atomic Energy Authority was set up, we cannot refrain from remarking that it seems to us overdue. In the development of any new device three broad stages can be discerned subsequent to the germination of the original idea. First the practicability of building the device must be demonstrated. Next the device must be shown either to be actually economic in operation or to promise economy within a few more years of development. These stages are, perhaps, as rapidly reached by a single research team as by many such teams. But the development of nuclear energy has already progressed past these two stages into the third stage. In that stage the engineering problems opposing further advance have become apparent. But—it is a point that pure scientists accustomed to finding sole correct answers to their problems often overlook—there is never a single ideal solution to an engineering problem. There are a multiplicity of ways in which engineering problems can be tackled, each having its own advantages and disadvantages. It is true that deep thinking can eliminate some of the possibilities as liable to lead to unreasonable demands upon production methods or to demands for materials with qualities not known to exist. But many routes of advance will still remain open. At this stage, therefore, the restriction of further development to the work of a single team becomes actively damaging. For any team, like any individual, develops its own predilections. Very naturally it regards the route of advance it has chosen as the one more likely to be fruitful than any other. It may, indeed, be by no means blind to the existence of other routes of advance ; but it will concentrate its energies upon its own. There is, therefore, an obvious advantage in setting other teams to work whose outlook will be different. Nor is the advantage of so doing restricted to that of ensuring that all promising routes of advance are explored. Each team becomes constructively critical of the work of others ; and cross fertilisation becomes active. Furthermore, the greater the number of teams and individuals fully informed about the problems the greater is the likelihood that fertilisation from some other apparently unrelated field will occur ; just as developments in the theory of aeronautics have led to the improvement of structures and of turbines, blowers and other machinery, besides aircraft. Unquestionably it seems to us the development of nuclear power plants has now well entered that stage at which further advance can only be rapidly stimulated by bringing in more teams and more individuals to work upon the problems involved.

If, however, the advantages of spreading knowledge more widely are really to be realised, practical as well as theoretical experience must be gained. Firms must be encouraged to form teams of nuclear power plant designers by the placing of orders for nuclear reactors by the British Electricity Authority. There economics enter the picture. At present nuclear plants are not economic generators of power. The objection, however, should not be held insuperable ; indeed, it appears to be one of the objects of the Atomic Energy Authority to ensure that it is not held insuperable. There is certainly justification for the building of nuclear power stations on the grounds of coal saving alone. Furthermore, it can be reasonably argued that as it is the service of capital that seems to be the major charge upon the operation of a nuclear power station such a station erected now and generating uneconomically may be expected to become a more economic unit as wage rates rise and the cost of coal increases, both of which seem to be inevitable changes. Yet one thing more is needed besides orders for power plants. It would be to stultify the advantages of having many teams at work if the existing secrecy about the detail design of nuclear power plants were maintained. Rapid advance can only be expected if free and frank discussion is permissible between individuals and teams and before Institutions and if detail designs can be published in the Press. Nor until secrecy has been broken down will it be possible for many firms to decide whether or not it will be worth their while to send members of their staffs to the new school. We are thinking here, primarily, of firms which cannot expect to be directly interested in the design and construction of complete plants but which might be actively interested in the making of auxiliaries such as pumps, fans, filters, valves, instruments, &c., for the design of which a proper understanding of the technology of nuclear power may prove essential. If advance is to be rapid, therefore, we feel that the secrecy that has surrounded nuclear power development must be, and probably inevitably will be, broken down as the numbers of those that have attended the new school increase and the contributions to further advances made by erstwhile students multiply. If, therefore, British firms are to find in nuclear power plants a new form of export in the design and construction of which they have the opportunity to lead the world, then the lifting of the veil of secrecy is not merely something to be hoped for soon but has already become an urgent need.

SMOKE ABATEMENT

In an address to the annual conference of the National Smoke Abatement Society, on Wednesday of last week, Sir Hugh Beaver remarked that the Air Pollution Committee, of which he is chairman, "has virtually finished its report and it will be very shortly presented to Ministers." Naturally, he did not anticipate the findings and recommendations of that report. But the wisdom of what he did say was such as to make us hopeful, and no doubt the members of the Society also hopeful, that it will contain proposals that could usefully be applied and which might be acceptable to the Government, to local authorities, to industry and to the domestic user of fuel. One of his remarks particularly merits attention. Repeatedly estimates have been made of the heavy cost imposed upon the community by air pollution, through its influence upon health, its destructive effects upon buildings (it is largely to offset the ravages of attack by polluted air that £1,000,000 is to be spent on the repair of Westminster Abbey), and through the repeated need to wash and clean clothes, furnishing fabrics, &c. Quite startling figures have been computed for the annual cost. Yet Sir Hugh could say "We have given a lot of attention to that matter and we are satisfied that no figures that have been hazarded . . . really overstate the case"! Much of this expenditure could undoubtedly be saved. For Sir Hugh was quite right in emphasising a conclusion of the interim report of his committee that "the pollution of air by smoke can be cured." If the annual cost to repair the ravages of air pollution is really as high as has been computed, then Sir Hugh's further conclusion that expenditure upon smoke abatement "would be a very profitable investment" is also reasonable.

But expenditure upon smoke abatement has to be met by somebody, although the benefit will be felt by everybody, by some more than by others, but by all in some degree. It seems manifestly unfair that any large proportion of the expense should fall upon some limited group within the community if all are to benefit. The conclusion seems inescapable that much of the expense must be met by the Government and local authorities. But, as seen by the Treasury, expense of this kind would be one upon which there was no such direct return as there is, for example, upon expenditure for armaments. Nor would the expenditure amount, as that upon pensions and public assistance does, merely to a redistribution of wealth. And it is only quite lately that it has become accepted as a beneficent principle that the Government should contribute funds to, for example, research bodies whose work will benefit industry rather than bring in a direct return to the national exchequer. Thus if the Government and local authorities are to act they must first of all feel assured that they will have public backing. The key to effective action therefore lies (as indeed the interim report of the Beaver Committee made clear) in the instruction of the public about the effects of air pollution, about its cost to the community, and about the means to combat it. Moreover, since so large a proportion of the smoke produced comes from domestic chimneys, each member of the public needs to be shown that he individually must contribute if smoke abatement is to become effective. At present —so curiously is human nature compounded —a man can enthusiastically contribute to the funds of the National Smoke Abatement Society and at the same time fly up furiously in defence of the cheerful smoky flames from his open coal fire! How far has public opinion advanced beyond the almost complete apathy that existed some fifty years ago when that Society started to operate? Certainly the public has been shocked by the revelations about the London fog disaster of December, 1952. Presumably it is better informed now than it was before about the causes of that disaster. But how far is it appreciative that the damage done by air pollution is a continuously acting process? More crucially is the public prepared to expend money—its money, for it must come out of national and local taxation—in attacking air pollution?

One of the lines of attack upon air pollution undoubtedly lies in the modernisation of much out-of-date fuel-burning plant within industry. There it is fair enough that the firms concerned should bear part of the cost. For though the community will benefit by a reduction of smoke production, individual firms will benefit by savings in the cost of fuel. But even if those savings are sufficient to counterbalance the interest upon the investment in new plant; even if they will also counterbalance the higher wage that must necessarily be payable when a properly trained stoker replaces an untrained man; still in the majority of industrial establishments (other than those, like steel works, which are particularly heavy fuel users), the resultant savings are likely to prove almost negligible relative to other costs. Thus, because the community is likely to benefit at least as much as the firm, there is reason in the view put before the Beaver Committee by the National Union of Manufacturers that a financial incentive, through relief of taxation, should be offered to firms installing plant to raise their fuel efficiency. But smoke is one thing and sulphur dioxide is another. It will be noticed in our quotation from Sir Hugh's address that he was careful to qualify his remark that pollution could be cured to "pollution of the air by smoke." To rid the atmosphere of smoke would, indeed, be a great advance. But it would not be wholly to rid the air of pollution. The prevention of air pollution by sulphur dioxide presents a problem far more difficult to solve. It will be interesting to see in due course what the Beaver Committee has to say about it.

Obituary

A. B. COOPER

WE have learned with regret of the death of Mr. Ashton Burton Cooper, a director of Ferranti Ltd., which occurred at Toronto, Canada, on September 15th. Mr. Cooper, who was seventy, was born at Bloomfield, Ontario, and studied electrical engineering at Tufts College, Boston, Mass. After two years with The General Electric Company of America, and a year with the Westinghouse Company, Mr. Cooper joined the Brazilian Traction Company. He assisted in the construction of the first hydro-electric generating station for the supply of power to Rio de Janeiro.

Mr. Cooper returned to The General Electric Company of America in 1908, and five years later joined the Canadian General Electric Company to take charge of transformer sales. In 1922 he was appointed general manager of Ferranti Electric, Ltd., Mount Dennis, Toronto, and became president of the company in 1942. He was elected a director of the parent company, Ferranti Ltd., in 1947. Mr. Cooper was a member of the Institution of Electrical Engineers, a past vice-president of the American Institute of Electrical Engineers, and a past-president of the Canadian Electrical Manufacturers' Association. He had also served as director and president of the Toronto Industrial Commission and as director of the Canadian National Exhibition.

SIR JAMES CAIRD, BART.

As we go to press, we have learned with regret of the death of Sir James Caird, first Baronet of Glenfarquhar, which occurred on Monday, September 27th, at The Well House, Arthur Road, Wimbledon. Sir James, who was in his ninety-first year, had spent his long career in the British shipping industry. He will be particularly well remembered by the active part which he took in the restoration of H.M.S. "Victory," and by his generous assistance in the establishment of the National Maritime Museum at Greenwich.

Literature

Deep Drawing. By J. WILLIS. London: Butterworth's Scientific Publications, Ltd., 88, Kingsway, W.C.2. Price 25s.

WHEN a production technique has been so long established as that of deep drawing, the accumulated experience of generations is usually able to engage and defeat the practical problems encountered. Indeed, there are few problems in the field of presswork, and deep drawing in particular, that the enlightened and up-to-date technician will not take in his stride. This being recognised, it must then be admitted that even up to the present day deep drawing has remained an art rather than become a science. Should one of these progressive technicians be asked why he could perform such seemingly impossible things with sheet metal, he would probably be honest enough to admit that he did not know. He need feel no disgrace in this, for, indeed, few scientists (until recent years) could give a different answer. Scientists and research workers are the first to acknowledge that the progressive technician, so far, has always been the first to find the answer to the question "How?" Now the scientist is trying to give the answer to "Why?" and the contents of this book are the result of a serious attempt to supply the answer.

It must be remembered that it is a review of prolonged and intelligently planned scientific investigations and therefore is not a textbook of formulæ for draughtsmen. Much useful information for the guidance of press tool designers will, however, be found in its pages and, from the information contained, formulæ can (and possibly will) be ultimately developed.

From the results of the experiments undertaken the reader will be able to obtain a much better understanding of the mechanics of deep drawing.

It became obvious several years ago that intelligent explanations must be advanced for the ability of sheet metal to assume such intricate shapes when subjected to controlled

pressure. Under the auspices of the Motor Industries Research Association, in the first instance, and latterly the British Iron and Steel Research Association and the British Non-Ferrous Metals Research Association, Professor H. W. Swift, of Sheffield University, undertook a planned investigation into the factors and mechanics influencing plastic deformation of metal. The task was a formidable one, and a less able man than Professor Swift may have been discouraged by the problem. The magnitude of the task may be visualised from the fact that seventeen years have so far been devoted to the subject and much work remains to be done. In the course of these investigations much knowledge and data have been accumulated, a large amount of which has been published as individual items in scientific journals and papers to learned societies. So far, however, the results of all these labours have remained scattered, but at last in this book an attempt is made to collate and review Professor Swift's work so that it will become readily available to a much wider public.

The designs for, and principles of, the experimental equipment described in chapter I are worth studying, for these are directly applicable to press shop practice. The author points out that the chapters 2 and 6 are of an academic nature and may be omitted at a first reading of the book. This is a wise precaution, and the reader is advised to follow this injunction and absorb the contents of these chapters gradually. The deductions drawn from the theory of deep drawing are in line with logical industrial observations. When the work described in these chapters is fully understood it is possible that it will lead to the formulation of a fairly simple set of rules and factors for tool design. When careful study of experimental proofs is made, it will be realised how remarkably close to the apparent ideal the practical industrial worker has arrived. For instance, the work on die radii has shown that the maximum ideal die radius is about ten times metal thickness, whereas the practical man has for years been using about eight times metal thickness, as above this figure wrinkles form when the pressure plate loses control at the die edge. Many such instances occur in the course of this work. It is one more proof that the practical man found the way ; this book is telling him why he was able to do it.

At a first glance one may be tempted to say that the chapter on the shearing of metal bars and blanks is out of place in a work devoted to the scientific aspects of deep drawing. The intelligent technician, however, will see, on second consideration, how important this operation can be as a factor influencing the success or failure of the drawing operation. Undue work hardening on the edge of the blank, or excessive burr, can turn a border line case into a complete failure, whereas a perfect blank would result in success.

This book is abstracted from original reports of work carried out and, if a criticism might be offered, it does appear that on certain of the graphs and plots of results the notations obviously refer to items which do not appear in the book, but are in the original reports. Altogether this book is to be recommended to those seriously interested in the fundamentals of deep drawing, such as research workers and industrial investigators. Advanced tool designers will find in it much to assist them and, for those of an inquiring turn of mind, it will provide much to encourage them to persevere in their own work of investigation and development. Finally, the reader is urged to bear in mind that the work of seventeen years is covered by this book. It must therefore be obvious that, in a book of this size, only the briefest coverage can be given to such a large volume of experimental work. The author is to be complimented in having done it so admirably.

The Lady Isabella Waterwheel of the Great Laxey Mining Company, Isle of Man, 1854–1954. *A Chapter in the History of Early British Engineering*. By ANDERS JESPERSON. E. C. Kneale, Laxey, I.O.M. Price 20s.

ON September 27, 1854, the Lady Isabella Waterwheel of the Great Laxey Mining Company, in the Isle of Man, was started with ceremony and festivity, being named after Lady Isabella Hope, the wife of the Governor. The wheel, which was designed and built by Robert Casement, ran until 1929, when the mines were closed, and in 1938 was taken

The Lady Isabella Waterwheel of the Great Laxey Mining Company

over and repaired by Mr. E. C. Kneale, a builder, of Laxey, by whom she is now preserved and run for the benefit of visitors. To celebrate her centenary Mr. Jesperson has published this book, which deals with the wheel from every aspect—historical, topographical, meteorological, geological, and constructional, as well as with the mine she served.

The wheel is 72ft 6in diameter by 6ft wide and is the largest ever built. She is of the pitchback type—that is to say, water is fed from above the wheel, which turns towards the water supply. The penstock feeding the wheel is supplied by a 600mm cast iron pipe, siphoning water from a cistern in the hillside to the top of a tapering stone tower, round the outside of which is a spiral staircase terminating in a platform above the wheel and penstock. The power from the wheel was used for draining the mine and was transmitted through a crank and a horizontal rod, 190m long, to the pump rod, which raised the water from the bottom of a 402m shaft, and a maximum of 200 h.p. was developed.

It was built because there was no coal in the Isle of Man, but plenty of water at a good head, and the wheel, which is situated in Glen Roy, had a catchment area of 15,754 square kilometers in Laxey Glen and Glen Movar ; it was a whole-time job for one man to keep the 12·5km of lades clear. The percolation of water into the adits was approximately constant, but the deepest levels could only be drained in wet weather, as in dry weather there was only sufficient water to develop about 80 h.p. at the wheel.

The weight of the wheel is carried by a stone-built close-fitting arched casing and the water meets the wheel 13 deg. back from the vertical, shrouding below the penstock preventing the wind from blowing the water out of the buckets. Even so, with the present reduced flow of water, the wheel will not turn in the right direction in a northerly gale. The wheel runs on cast iron bearings and has a rim built of twenty-four double cast iron segments, each having seven buckets, which are connected to a cast iron hub with forty-eight arms and ninety-six tie rods, half the rods being crossed to give lateral stability. There is also an intermediate cast iron strengthening ring at each side.

The normal speed was from $2\frac{1}{2}$ to 4 r.p.m. and the horizontal rod was supported on rollers on a narrow stone viaduct and the vertical rod was partly balanced by balance boxes acting through levers on it. The wheel first raised the vertical rod and the two lower buckets and the main working stroke was from nine o'clock to three o'clock, when the weight of the rod itself operated five plunger pumps.

The book contains no less than 195 photographs and drawings, including a fine measured drawing of the wheel and its tower and casing made by the author. He has also analysed mathematically not only the wheel itself and its performance, but also its siting, water supply and the mine it served, and since his calculations are printed in extenso he may be said to have produced a completely exhaustive account of all pertaining to the wheel. As the book is written in English, it seems a pity that the author should have mixed metric and English units in the way he has. It would have been more useful for purposes of comparison if in all cases the engineering and architectural features had been given in addition in the English units to which they were built.

Introduction to Nuclear Engineering. By RICHARD STEPHENSON. London : McGraw Hill Publishing Company, Ltd., McGraw Hill House, 95, Farringdon Street, E.C.4. Price 57s. 6d.

IN just over 350 pages, this book sets out to provide an introductory course in nuclear engineering to those who have completed a conventional engineering curriculum. That it is difficult to find suitable standards against which the book may be judged is perhaps merely another way of saying that the need which it seeks to fill is a very real one. The popular works on nuclear energy do not go sufficiently deeply into the subject to satisfy the engineer, whilst the more serious publications are only too often written for those with more specialised knowledge than the engineer possesses.

A glance through the book gives a most attractive impression of material that can readily be assimilated by the engineer and used by him to solve a wide range of problems, whilst forming a useful starting point for more advanced study. The printing is clear, the style is readable, and the text is liberally interspersed with worked examples, additional problems being added at the end of each chapter.

The first chapter reviews the basic information on atomic structure, radioactivity and nuclear reactions. These ideas are extended in the second chapter to a brief study of nuclear fission. The third chapter describes

various nuclear reactors constructed to date. These are mainly heterogeneous, natural uranium, graphite or heavy-water moderated, thermal neutron devices, although a few similar reactors using enriched fuel are noted and mention is made of homogeneous thermal reactors. The principle of breeding is also discussed and is followed by a description of a fast reactor designed for this purpose.

The following chapter, occupying some sixty pages, deals with the theory of nuclear reactors, and opens with a fairly detailed treatment of the theory of neutron scattering, and consequent neutron energy distribution. The expression for the resonance escape probability in terms of the resonance integral is next derived, and resonance capture in homogeneous and heterogeneous reactors separately discussed. Brief mention of the fast fission and thermal utilisation factors then leads naturally to definition of the multiplication factor, with examples of its calculation for different types of reactor.

A section on the theory of neutron diffusion follows, and at the outset the analogous theory of diffusion of heat is presented, together with some discussion of Laplace's equation which this presentation involves. Derivation of the relation between neutron flux and current leads naturally to that of the general diffusion equation, and its associated boundary conditions. Applications of the equation to the calculation of neutron flux distributions in reactors and reactor critical sizes are described by means of worked examples.

The fifth chapter is a treatise on nuclear radiation shielding. The types of radiation are first described and their allowable intensities quoted. The gamma-ray absorption coefficient is defined and its dependence on photon energy in different materials described. The gamma-ray build-up concept is also introduced. Formulæ are derived for the variation of gamma radiation intensity with distance from the source for several source-shield arrangements, both with and without self-absorption. The chapter concludes with a brief discussion of neutron shielding and nuclear heat generation in shields.

A chapter follows on materials of construction, with particular reference to the effect of radiation on them, and to their properties as moderators, coolants and radiation shields. The seventh chapter discusses instrumentation and control, and the eighth the separation of stable isotopes, covering the electromagnetic, centrifuge and gaseous diffusion methods. The book concludes with a chapter on chemical separation and processing followed by one on remote handling of radioactive materials. Appendices list conversion factors and constants, common radioisotopes, neutron absorption cross sections, and properties of moderators.

The reviewer considers that the presentation of the theory of neutron scattering before that of neutron diffusion is an excellent choice of order, although the expenditure of an additional page on the derivation of the expression for resonance escape probability might have made for far readier comprehension. In this connection, it is felt that use of the same symbol for neutron flux per unit energy in equations 4–23 and 4–24 is confusing. Again, the derivation of the transport mean free path in terms of the scattering mean free path and mean angle of scatter is considered to be somewhat naive. Misprints would appear to be few and, where they occur, fairly obvious. To sum up, this book is thought to be excellent reading for the engineer who wishes to make a serious inroad into the study of nuclear engineering.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE NAVY'S MANPOWER PROBLEMS

SIR,—Your leading article on naval manpower is timely and welcome. Though I am mainly concerned with the electrical engineering branch my remarks have a wider application.

Being a good naval officer is not something confined to the executive branch and it must not be assumed that it is incompatible with being a good electrical engineer. A technical officer in the Royal Navy must lead and administer men (not only naval ratings in ships and shore establishments but also civilians in dockyards, &c.), and he must be trained to do so. It is surely not contemplated that the technical ratings and workmen should be administered by the executive side and the engineer restricted to the drawing board and the slide-rule.

It is just such divorcing of the engineer from administration in industry which Mr. Bosworth Monck condemns so strongly in his paper, "Status of the Engineer in Management," read before the British Association. We cannot expect to have a technical officer on the Board of Admiralty unless the technical officer is trained in management and administration, unless, in fact, he is a good naval officer.

As I am myself one of H.M. servants may I ask you to respect my anonymity ?

"M.I.E.E., A.I.Mar.E."

Portsmouth, September 14th.

WILLIAM MURDOCH(K), 1754–1839

SIR,—The recent article in your issue of August 27th last, on the bicentenary of William Murdoch requires some comment and amplification. The importance of the centenary of his death in 1839 was not recognised. It was an irony of fate that the proposed celebrations to honour the man who gave "light" to the world should have been "blacked out" because of the outbreak of war. Had they taken place there might have been more publicity for the bicentenary of his death.

It should be noted that Murdoch and Trevithick were not—as indicated—simultaneous independent inventors of the steam road carriage. Murdoch's invention was running on the roads around Redruth when Trevithick was but a lad of thirteen, living near. He was a regular visitor at Murdoch's house, and it is said that he bought Murdoch's model steam locomotive when all his efforts to patent it were opposed by Boulton and Watt. The date of Murdoch's invention was 1784, that of Trevithick was 1803. The then princely salary of £1000 was offered to induce him to return to Soho, not from Redruth, but from Old Cumnock, where he had gone a year earlier to start a gas-making foundry of his own. This step was taken in discouragement at the firm's refusal to take out a patent for his gas-making invention.

There was a short biographical sketch of the inventor written by my father in 1892, entitled "Light Without a Wick." It was done at the request of the North British Association of Gas Managers, for the centenary of gas-lighting. He had intended writing a fuller life, but his early death intervened. Two years ago I learned that a life of William Murdoch written, or at least completed, by Mr. Arthur Elton, was ready for publication, but for want of financial guarantee it had not been published. Surely, in this the bicentenary year of so great an inventor, there could be money made available to finance this biography ?

The want of provincial recognition of the occasion is difficult to understand. In Stirling a wreath was laid by the Bust of Murdoch in The Hall of Heroes, Wallace Monument. *The Scotsman* published a long tribute to "a neglected genius," and two shorter articles appeared in the Scottish press, but one might have expected that every daily newspaper would have a contribution to make for the bicentenary of one, who, by his inventions, was one of the greatest contributors to modern industry and transport. In London an exhibition of gas in all its uses was promoted by The Gas Council and the Institution of Gas Engineers. This is housed in a gallery of South Kensington Museum of Science. The latter of these promoters has arranged a Murdoch Memorial Lecture to take place on October 5th. The Gas Council recently produced a film, "The Vital Flame," dealing with the gas industry and Murdoch's part in it. This is being shown in the schools, but it shows him only as the inventor of gas-lighting, and not what he really was—a great engineer.

MARGARET L. MURDOCH

Glasgow, September 8th.

[Our correspondent is a great-grandniece of William Murdoch.—ED. THE E.]

Short Notices

Electro-Plating and Corrosion Prevention. Edited by E. Molloy. London : George Newnes, Ltd., Tower House, Southampton Street, W.C.2. Price 18s.—The book deals in a straightforward manner with the methods and compositions used for electro-plating the industrially important metals and alloys, including precious metals, and such modern developments as reverse current plating and tin alloys. There are chapters on industrial plating equipment, applications to the printing and hardware trades, and the testing of deposits. Anodising and chemical surface treatments for corrosion protection are discussed in the later chapters which include one on magnesium alloys and one on metal-spraying processes.

Chemical Engineering Instruments and Control Methods. Edited by E. Molloy. London : George Newnes, Ltd., Tower House, Southampton Street, W.C.2. Price 21s.—For those concerned with chemical engineering techniques, this book provides a practical guide to instrumentation. Amongst the subjects included are pH meters, photo-electric instruments, polarimeters, colorimeters, moisture testing equipment, pressure controllers, liquid level indicators and ultrasonic equipment. There is a chapter on the construction and uses of the manipulator box (for handling poisonous substances), and an elementary discussion of the theory of process control. Two widely used control systems are described in detail.

Books Received

Practical Gear Design. By Darle W. Dudley London : McGraw-Hill Publishing Company, Ltd.,. McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 50s.

Year Book of the Heating and Ventilating Industry. Eighth Edition. London: Technitrade Journals, Ltd., 8, Southampton Row, W.C.1. Price 7s. 6d.

Significance of Properties of Petroleum Products. Edited by George Sell. London: The Institute of Petroleum, 26, Portland Place, W.1. Price 7s. 6d.

Constructional Steelwork Simply Explained. Third Edition. By Oscar Faber. London : Oxford University Press, Amen House, Warwick Square, E.C.4. Price 12s. 6d.

Diesel Locomotives, Mechanical and Electrical Fundamentals. By J. Drawey. London : The Technical Press, Ltd., 1, Justice Walk, Lawrence Street, S.W.3. Price 39s.

S.S. "Ocean Vulcan" Sea Trials. Detailed Analysis of Record No. 6.W.5 (Ballast Condition). Report No. R.11 of The Admiralty Ship Welding Committee. London : Her Majesty's Stationery Office, York House, Kingsway, W.C.2. Price 27s. 6d.

A Selection of Graphs for Use in Calculations of Compressible Air Flow. Prepared on behalf of the Aeronautical Research Council by the Compressible Flow Tables Panel. London : Oxford University Press, Amen House, Warwick Square, E.C.4. Price 84s.

British Electricity Authority's Report

ON September 28th the British Electricity Authority published its sixth annual report and statement of accounts, covering the year ended March 31, 1954. The following abstracts give some of the main factors of the year under review.

Financial.—The Central Authority had a surplus of £8,011,727 compared with £5,824,452 in 1952–53, and the aggregate surplus of the fourteen Area Boards was £5,177,011, as compared with £1,456,371 in 1952–53.

The financial results of the Authority and individual Boards for the year were as follows :—

	£
British Electricity Authority	8,011,727
London	1,160,009
South Eastern	105,875
Southern	603,794
South Western	98,256
Eastern	195,261
East Midlands	240,975
Midlands	381,251
South Wales	193,248
Merseyside and North Wales	539,289
Yorkshire	269,143
North Eastern	419,146
North Western	1,021,523
South East Scotland	236,027
South West Scotland	315,486
Total	£13,188,738

In the last six years the aggregate surpluses of the Central Authority and the fourteen Area Boards have amounted to £41·5 million.

Revenue Per Unit Sold.—The average price received for electricity sold for all purposes was 1·373d. per unit. This was 4·7 per cent above the 1952–53 average, 21·2 per cent above the average of 1947–48 and 30·1 per cent above that of 1937–38. The average price increase for electricity since before the war is very much less than price increases for practically all other commodities and services and far below the increases in costs to the Authority and the Area Boards for plant and equipment, civil engineering works, buildings, fuel, materials, labour, transport and goods and services of many kinds.

Average Charges to Consumers, Pence Per Unit

Consumer	1953–54	1952–53
Domestic	1·532	1·452
Industry	1·143	1·088
Farms	1·467	1·397
Commerce	1·913	1·831
Traction	1·089	1·016
Public Lighting	1·393	1·337

Number of Consumers.—At March 31, 1954, the number of electricity consumers exceeded 14,380,000, representing an increase of 529,685 in the year. New supplies were given to 12,948 farms, bringing the total number of farms connected to 152,507.

Supply.—Consumers purchased over 55,800 million units of electricity in 1953–54 or 6·9 per cent more than in the previous year, and an increase of over 57 per cent in the six years since vesting day. Roughly half the sales were to industry, a third to domestic consumers and a seventh to commercial consumers. Industrial consumption was 9·8 per cent more than in the previous year, domestic 2·9 per cent, public lighting 7·4 per cent, commercial 5·8 per cent, and farms 15·8 per cent.

Increase in Costs.—Continued improvement in efficiency, particularly in the generation of electricity, accompanied by the recovery in the rate of growth of sales, did much to mitigate the effect of increased costs, which were due chiefly to an increase of over 6 per cent in the average delivered cost of fuel per ton (due to the 10 per cent increase in pithead prices of coal in March, 1953, and further rises in fuel transport charges). This added some £7,500,000 to fuel costs and increases in salary and wage rates accounted for another £3,000,000. Some increases in charges to consumers were therefore inevitable.

Capital Expenditure.—Capital expenditure during the year amounted to £170 million (£103 million by the Central Authority and £67,000,000 by the Area Boards), making the gross value of fixed assets £1600 million.

Generating Plant.—At March 31, 1954, the Central Authority owned 288 power stations with a total installed generating capacity of 18,647,247kW and a total output capacity, assuming all plant in service, of 16,904,000kW.

Total output capacity has increased by 50 per cent since vesting day. New plant brought into service in 1953–54 gave an additional output capacity of 1,419,000kW. Taking into account the removal of some old plant and the revision of some plant ratings, the net increase in output capacity was 1,369,000kW.

In the six years to March 31, 1954, the Authority has commissioned forty-four new stations (including sections of stations which are virtually new stations). During the past year the following eight new stations were brought into partial operation:

	Kilowatts sent out
Bold " A " (St. Helens)	28,000
Carmarthen Bay (Burry Port)	100,000
Carrington (near Manchester)	56,000
Chadderton (Oldham)	35,000
Connah's Quay (near Flint)	56,000
Doncaster " B "	28,000
East Yelland (near Barnstaple)	56,000
Roosecote (Barrow)	56,000
Total	415,000

Future Building Plans.—The Authority plans to increase its generating capacity by over 50 per cent during the six calendar years 1954 to 1959. This represents a net addition of some 8,600,000kW of output capacity, from nearly 16,900,000kW at the end of 1953 to 25,500,000kW at the end of 1959. To achieve this, nearly 10,000,000kW of new generating plant will be provided and over 1,000,000kW of old plant will be shut down to make way for new plant or because it is no longer usable.

Advances in Design.—Whereas in recent years there has been a preponderance of " standard " 30,000kW and 60,000kW generating sets, sets of 60,000kW and under provide only one-third of the capacity of plant planned to be installed in 1959. In that year four 100,000kW sets, five 120,000kW sets, and the first set of 200,000kW, are scheduled to come into commission.

The 200,000kW set, new to this country, will operate at 2350 lb of steam per square inch and 1050 deg. Fah. (compared with 900 lb per square inch and 900 deg. Fah. of a 60,000kW set).

Electricity Output.—Over 66,000 million units of electricity were generated by the power stations during 1953–54 or 7·3 per cent more than in the previous year, 58 per cent more than in the year before nationalisation and two and three-quarters times as much as the comparable production in 1938.

Despite the improvement in the generating plant situation, it is still necessary to retain in operation many generating sets and boilers which are old, small and expensive to operate. More than two-fifths of the generating sets and boilers in the steam power stations, representing over 17 per cent of the total generating capacity and nearly 15 per cent of the total steaming capacity are over twenty-five years old.

Thermal Efficiency and Fuel Consumption.—The overall thermal efficiency of the Authority's steam power stations has risen steadily from 20·87 per cent in 1947–48, to 22·04 per cent in 1951–52, 22·72 per cent in 1952–53, and 23·40 per cent in 1953–54.

These improvements constitute a saving of 12,000,000 tons of coal over the last six years.

The Authority continued to be the largest individual purchaser of coal in Great Britain. Fuel consumed in its power stations during 1953–54 amounted to 37,250,000 tons, of which a little over 36,000,000 tons was coal. Total fuel consumption was 4·3 per cent more than in 1952–53. The difference between this percentage increase and the corresponding increase of 7·3 per cent in electricity generated reflects further improvements in efficiency of generation.

Average works costs per unit of electricity sent out from the steam stations, however, increased by only 2·7 per cent from 0·5446d. in 1952–53 to 0·5594d. in 1953–54.

Operation.—The margin of available generating capacity is still precariously small and in abnormal weather conditions interruption of supply to some consumers might still be unavoidable on occasions. The maximum potential demand on the system occurred on Tuesday, February 2nd last, and amounted to 16,309,000kW, compared with 14,850,000kW in the previous winter. The demand actually supplied by the plant available at the time was 15,430,000kW, the difference of 879,000kW representing the estimated amount by which the load was reduced by low frequency and reduction of voltage.

Supergrid.—The Grid system of main transmission lines owned and operated by the Central Authority at March 31, 1954, comprised 5155 route miles, of which 41 route miles operated at 275,000V, 4615 route miles at 132,000V and the remainder at 66,000V or lower voltages. The major Grid development work put in hand during the year included 16 route miles of 275,000V lines and 224 route miles of 132,000V lines. Sixteen more new points of supply to Area Boards' networks have been installed, making a total of ninety-seven in the six years since vesting day.

Rural Electrification.—It is planned to spend some £130 million over the next ten years on the extension of rural supplies. Of this sum £100 million is required for extending and reinforcing the distribution networks, and £30,000,000 for increasing generating capacity and extending and reinforcing the main transmission system.

During the five-year period ending March 31, 1958, the Boards aim to take electricity to an additional 60,000 farms and some 260,000 other rural houses and premises, at an estimated cost of £50,000,000. During the subsequent five years, at a similar estimated cost, it is proposed to connect an additional 45,000 farms and a corresponding number of other houses and premises.

Nuclear Generation.—The Authority has set up a special branch of its headquarters engineering department to study, plan, design and eventually arrange for the construction of nuclear power stations. The rate of progress will depend primarily on the results of the research and development undertaken by the new Atomic Energy Authority to which engineers of the B.E.A. will be seconded. It is hoped to begin within the next few years the construction of a nuclear power station employing generating units each with a capacity of 60,000kW or even larger.

Thereafter, the Authority hopes to be in a position to undertake the building of nuclear power stations as a regular part of its normal activities. Such stations will almost certainly be built for base-load generation—they will be kept in continuous operation as far as practicable—and therefore will fairly quickly have a material effect on coal requirements for electricity supply. Information at present available indicates that, in the long term, electricity produced from nuclear fuel may be competitive in price with that produced from coal.

Pipe Defroster

A PORTABLE pipe defroster which is operated from the normal single-phase a.c. supply, is being manufactured by Radford Electronics, Ltd., 149, Newfoundland Road, Bristol. Known as the Radford defroster, it consists of a 2kW stepdown transformer and a set of heavy duty cables 15ft and 45ft long. Longer cables can be supplied to deal with lengths of piping of up to 100ft in a single operation. The cables are connected to the pipe on either side of the frozen portion and current is allowed to flow until the pipe is free again. It is stated that a ½in pipe can be defrosted at the rate of 9ft per minute. There is no danger to personnel owing to the low voltage used, and the equipment is protected against damage from accidental short-circuits.

BARREL FINISHING MATERIAL.—A material for use in barrel finishing of metals has been developed by Lacrinoid Products, Ltd., Gidea Park, Essex. This material, known as " Lacron," consists of mineral oxide chips, which are available in nine sizes from 2in down to $^{1}/_{32}$in, and they can be used in conjunction with any of the ordinary polishing compounds. No special form of tumbling equipment is required when using the chips.

Post Office Engineering Research

AN open day at the Post Office Engineering Research Station, Dollis Hill, on Thursday, September 23rd, gave us the opportunity of seeing some of the many and varied aspects of research work undertaken by the General Post Office.

To appreciate the growth of these activities it is of interest to recall that, although the Post Office was conducting experiments in telegraphy as long ago as 1870, it was not until 1904 that staff were specifically designated for experimental work. A research section was formed by 1909, but the original laboratories near St. Paul's gave little scope for expansion. These disabilities were, however, removed in 1917 by the acquisition of the present site at Dollis Hill. When the staff began to move in in 1921 the accommodation consisted of Army huts, but in 1933 the main block of the present buildings was opened and extensions have been added from time to time, including, within the last few years, new workshops and a drawing-office.

The main function of the Research Station at Dollis Hill is to maintain and improve the efficacy of the Post Office telecommunication services ; the work therefore embraces the study of new phenomena, techniques and materials, and the development of new experimental systems and apparatus. Investigations and development work on systems already approved or in use are outside the scope of the research station and are carried out by other laboratories of the G.P.O. engineering department. Some extra-mural work is also done on behalf of other Government departments.

Briefly the work in progress is concerned with telephone instruments, measurement of transmission, electro-acoustics ; switching and signalling in telephony and allied fields ; amplifiers, equalisers and measuring instruments for long-distance land and sea cables ; multi-channel equipment ; systems and apparatus for telegraphy ; radio telephone and telegraph transmission, reception, propagation and interference ; application of piezo-electric crystals to frequency control and selection ; frequency standards ; the mechanisation of the handling of mail ; television transmission by cable and radio ; thermionic valves and transistors and their circuitry ; physical and chemical studies of materials for telecommunications ; mathematical and statistical studies.

Electronic Private Automatic Branch Exchange.—One of the interesting exhibits that we saw on our tour of the laboratories was an electronic private automatic branch exchange which has been built to provide experience of electronic switching. It is equipped with fifty lines (but can later be increased to ninety-nine lines) and is arranged to handle a portion of the internal telephone service of the Dollis Hill research station. Whereas the conventional means of providing an automatic telephone service is by electromechanical switching, the system of electronic switching involves no moving parts. Each line is allocated a very short electrical pulse which is repeated at rapid intervals, the pulses for the different lines being interleaved at intervals of one-millionth of a second. The speech and signalling information for a particular line is conveyed by varying the amplitude of the electrical pulse allocated to that line.

Submarine Telephone Repeaters.—Another group of exhibits was arranged to show something of the work that has been done by the Post Office to develop the use of submerged telephone repeaters to such a point that the existing system of these repeaters near the British Isles is more extensive than elsewhere in the world. One exhibit, the standard shallow water repeater, provides sixty high-grade telephone circuits on one cable, in the frequency bands 24–264 kc/s in one direction of transmission and 312–552 kc/s in the return direction. The normal cable is an 0·62in polythene-insulated coaxial cable and, if required, up to ten repeaters can be inserted at about 20-mile intervals. The repeaters are energised in series from a shore station with a constant current of 0·3A and each repeater absorbs about 250V. A radar pulse gear devised by the Post Office locates any faulty repeater. Experience gained on shallow-water repeaters led to the development of a deep-sea repeater (which was also exhibited). Hydrostatic pressures of up to 4 tons per square inch then presented difficulties, particularly in the sea cable glands, which also had to withstand 2500V d.c. The research station solved the problem by developing a polythene seal ; the cylindrical surface of the steel core of the gland was ribbed and lead plated, so that, by applying a polythene sheath in a heated mould and by slow, controlled cooling it was possible to obtain a good seal between the polythene sheath and the lead-plated steel, capable of withstanding a pressure of 5 tons per square inch. The deep-sea housing of the repeater has a streamlined cigar shape about 9ft long and 11in diameter and is laid in line with the cable, as distinct from the much larger shallow-water repeaters which are lowered by a rope to the bottom. This type of repeater will be used to provide sixty circuits on the British section of the Transatlantic telephone cable. The amplifier consists of two forward-amplifying paths in parallel, so that the failure of any component in one path will not seriously degrade the performance of the repeater.

Reliability of a standard never before attempted is required of these repeaters, and the aim is a life of twenty years. The construction of the hermetically sealed electrical units is carried out in air-conditioned rooms, under conditions of scrupulous cleanliness, with rigid inspection at all stages. Intensive work in recent years has led to an efficient long-life valve, and the Post Office is confident that the valves manufactured in its laboratories will meet the onerous requirements.

Quartz-Crystal-Controlled Speaking Clock.—The prototype of a new design of "speaking clock" driven electrically by a quartz-crystal-controlled oscillator, was on show. Its accuracy is such that, if the correcting signal from the observatory is applied only once in twenty-four hours the maximum error will never exceed 0·005 second. By comparison, the existing "TIM" service, which is pendulum-controlled and receives hourly correcting signals from Greenwich, has a maximum error, during each hour, of 0·1 second. The new clock which is destined for Australia was required to have the accuracy stated so that it could be used for checking ships' chronometers. When the observatory signal has been received and compared with the time given by the clock the error will be reduced automatically in 1 millisecond pulses. After this correction has been applied the error will be less than 1½ milliseconds and the drift of the crystal controlled circuits will limit the cumulative error in the next twenty-four hours to 3½ milliseconds.

Cutting Quartz Crystal.—A novel design of saw for cutting quartz crystals without excessive wastage of quartz was demonstrated. The saw consists essentially of a thin circular disc with a central hole of about 3in diameter ; the inner circumference constitutes the cutting edge and the outer circumference of the disc is clamped over a wedge-shaped ring to produce a condition of tension in the disc, including the cutting edge. This tension is such that although the disc is much thinner than the normal circular saw it produces an accurately repeatable cut. By this means, we were told, the thickness of the saw-cut can be reduced from 0·040in to 0·014in, with a corresponding reduction in the amount of quartz lost as dust. To make the best use of the potential accuracy of this method of cutting, a special table and feed has been developed and the orientation of the workholder can be checked by an optical method to ensure that the departure from parallelism between the faces of a quartz slice does not exceed one minute of arc.

Scanning Receiver for Radio Monitoring.—Because of the overcrowding of the æther, not only in the medium-wave broadcast bands but also in the short-wave bands used for long-distance telegraphy and telephony, it is becoming increasingly hard to find suitable allocations for new services. Manual searching of the spectrum requires skilled operators and is tedious. The Post Office has therefore developed an automatic scanning receiver designed to produce a printed chart showing the extent to which a wave band is occupied ; gaps in the chart corresponding to the less crowded parts of the band show where the search can profitably be concentrated. The recording apparatus consists essentially of an electro-sensitive paper chart driven in synchronism with the tuning of a receiver which scans the required part of the spectrum. If at any frequency in the band under exploration a signal is received above a given level a record appears at the appropriate place on the chart which presents wavelength and time on rectangular co-ordinates. The sensitivity level required to produce a record can be varied.

Brief mention should be made of two more exhibits that we saw during our tour. The first involved a demonstration of a model technique for investigating aerial performance, whereby, through scaling down, experiments may be done indoors without the expense of erecting full-scale outdoor aerials (measuring, for example, 600ft by 70ft) and carrying out aerial or other surveys. The second exhibit was concerned with experimental line amplifiers developed by the G.P.O., using junction transistors. Two experimental designs of transistor were shown—one now undergoing field trials, being suitable for single speech circuits, and the other, a high-performance unit, having promise in connection with circuits for music reproduction.

Movable Laboratory Bench

DETAILS have been sent to us of a movable bench which is intended to help overcome the shortage of bench space met with in many laboratories. It is manufactured by Shandon Scientific Company, 6, Cromwell Place, London, S.W.7, and, as the accompanying illustration shows, consists of a table-top of about 5 square feet area. One side is supported

Movable bench in position on guide rail

by two adjustable legs fitted with castors, the other runs on a guide rail which is permanently fixed to the edge of an existing bench. Without interfering with cupboard doors or drawers, the bench can easily be moved to where extra space is required and can be locked in position by means of a lever.

INTERNATIONAL PRINTING EXHIBITION.—The tenth International Printing, Machinery and Allied Trades Exhibition is to be held at Olympia, London, from July 5 to 16, 1955. It is sponsored by the Association of British Manufacturers of Printers' Machinery, the organiser being F. W. Bridges and Sons, Ltd., Grand Buildings, Trafalgar Square, London, W.C.2.

Fourth European Machine Tool Exhibition

No. IV—(*Concluded from page 415, September 24th*)

THIS week we conclude our account of the machine tool exhibition at Milan, which closed on September 23rd.

Charles Berthiez

A new vertical boring and turning mill made by Charles Berthiez, 5, rue Montalivet, Paris, 8e, is of single-column design with a movable table. The 94in diameter table is designed to take work weighing up to 50 tons and 12ft 6in diameter.

As can be seen in Fig. 22, the arm of the machine moves on two front and one side slides on the massive column, and is heavily reinforced to give a high degree of rigidity. Arm adjustment is effected by an individual electric motor driving a screw through reduction gearing. Two tool heads are fitted on the arm and one side head on the column of the machine. Each tool head has a large rectangular section ram and is fitted with swivelling tool holders.

The table of the machine is powered by a Ward Leonard set through a variable-speed motor driving a three-speed gearbox. Final drive is by a spur wheel and a range of speeds from 0·45 to 85 r.p.m. is available.

For some years this firm has been building two-way planing machines, and this year it is showing a machine of this design fitted with one planing and one milling tool head. This machine is 79in wide between the columns and has a table stroke of 236in. When using the milling head a drive independent of the planing drive is engaged. This drive is obtained through a Ward Leonard set and a two-speed gearbox coupled through an intermediate worm and worm wheel to the same shaft as used in the planing drive. Table feeds can be varied between ½in and 17ft per minute.

The milling head can be used for both boring and milling and has a down feed of 31in. It is powered through the same Ward Leonard set as the table drive. The milling spindle assembly is mounted on a special carriage incorporating the motor drive so that it forms a completely independent unit. Drive from the motor is transmitted through a four-speed gearbox and spindle speeds up to 1000 r.p.m. are available. Spindle down feeds ranging from ⅜in to 16in per minute are provided.

Berthiez machines are handled in this country by Soag Machine Tools, Ltd., of London.

A. Mannesmann

A new rack milling machine for components up to 2500mm long and single or grouped components up to 300mm wide, developed by A. Mannesmann, of Remscheid-Bleidinghausen, Germany, is suited to cutting straight or helical teeth from pitch module 1 to 16 with all intermediate steps, according to the specification DIN 780. This machine, to be seen in Fig. 23, consists essentially of a heavy cabinet base with a fixed work table and a large inclined longitudinal slideway at the back. A carriage movable along the rear slide supports the main milling head saddle. The milling head is carried on a heavy cross slide on the saddle and mounted so that it can be swivelled up to 25 deg. on either side for cutting helical teeth.

The milling head carriage is traversed along its slideway by a leadscrew driven through a thirteen stage Norton gearbox by a 1½ h.p. motor. This leadscrew indexes the carriage according to the pitch of the rack being cut and during the actual milling operation the carriage is hydraulically locked to the slideway. The milling head is traversed across the work on the table by a separate feed motor through a nine-speed gearbox giving cutting feeds from 8·5mm to 183mm per minute. A rapid return motion of 1200mm per minute is automatically engaged at the end of each milling stroke of the head. The cutter spindle is driven by a 3·7 h.p. motor through a gearbox giving nine spindle speeds from 47 to 293 r.p.m. According to the size of the teeth being cut one or more cutters can be fitted on the milling spindle.

The machine is fully automatic in operation and when the working cycle is started the head moves across to cut the first tooth or teeth. At the end of the stroke the cross slide is lifted hydraulically to raise the cutter clear of the work before the head is retracted at the rapid return speed. The saddle clamps are then released and the head traversed the required distance for the next milling operation. The cross slide is then automatically lowered and, together with the saddle, is rigidly locked in position ready for the next machining stroke. This cycle of operations is repeated until the rack is cut and at the end of the last stroke the saddle is returned to its initial position at a high speed and the machine stopped for the removal of the finished component.

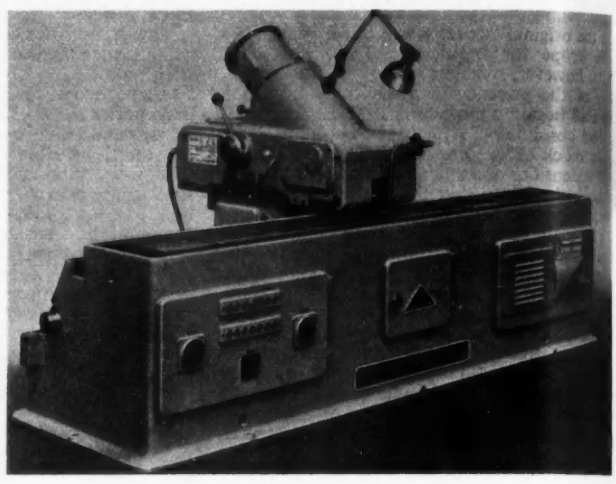


Fig. 23—Rack milling machine for racks up to 2500mm long and 300mm wide

For the longitudinal machining of slots a supplementary milling head attachment is provided and when this is fitted the cross slide is locked whilst the cutter is traversed along the work through the carriage drive. The cutter spindle speed range is from 47 to 293 r.p.m. and the thirteen feeds available are from 10mm to 43mm per minute. By using a 1 to 2 gear ratio further feeds from 50mm to 193mm per minute are available.

Schulze and Naumann

One of the large machines in the sheet metal working section of the exhibition is the roller shears with a 19m long top beam, designed to handle plates up to 9m long, built by Schulze and Naumann, of Essen, Germany. This machine is designed to cut plates up to 30mm thick and in addition to a vertical and an inclined shearing disc it is fitted with a supplementary planer slide. The planer slide is adjustable both vertically and horizontally on the main carriage, so that, if required, plates up to 250mm thick can be machined. Planing can be carried out in both directions of carriage travel and the range of speeds available enable tipped tools to be used.

Plates are held during shearing or planing by two carriages fitted with pneumatic clamps and a series of pneumatic rams projecting down from the top beam of the machine.

Berliner Maschinenbau A-G.

A boring and milling machine with automatic co-ordinate setting has been developed by the Berliner Maschinenbau A-G—formerly L. Schwartzkopff—of Scheringstr. 13–28, Berlin, 31, Germany. The general construction of the new machine can be seen in Fig. 24. It has a worktable 50in long by 30in wide and its spindle head carriage has a longitudinal traverse of 50in along the ways of a heavy bridge rigidly supported on heavy columns. The spindle, which has a transverse movement of 30in over the width of the table, has a vertical movement of 13in in the head. The table has a vertical adjustment of 17in and, if required, it can be removed to

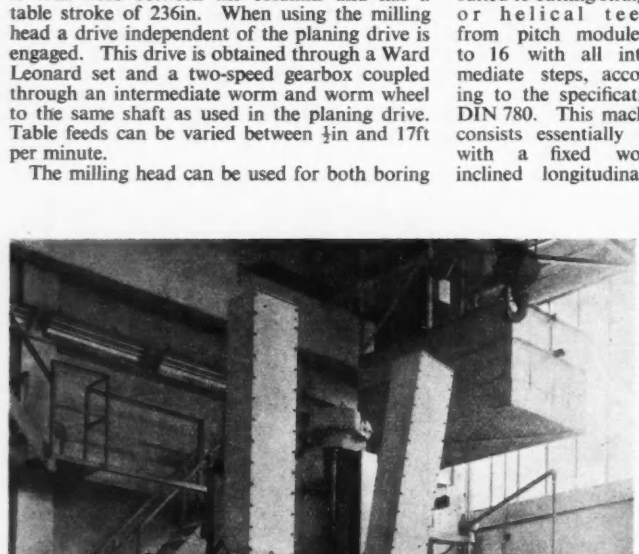


Fig. 22—Vertical boring and turning mill with table speeds from 0·45 to 85 r.p.m. and for taking work up to 12ft 6in diameter

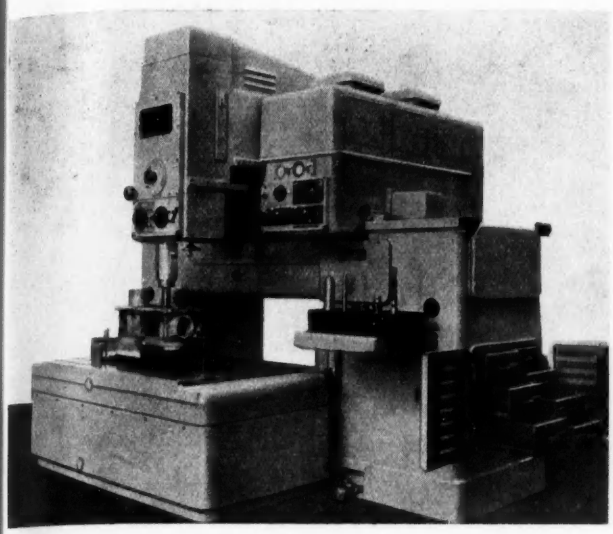


Fig. 24—Boring and milling machine with automatic co-ordinate setting

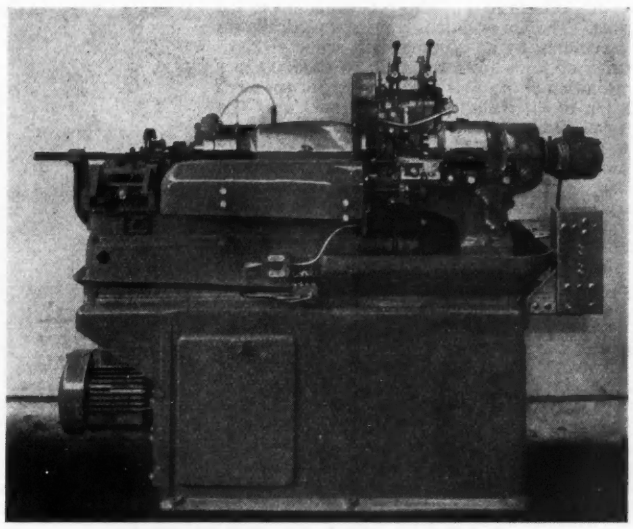


Fig. 25—High-speed sliding-headstock, cam-operated, automatic lathe for work up to 100mm diameter by 100mm long

enable large components to be mounted directly on the base-plate of the machine.

A 5½ h.p. motor in the head drives the spindle through gearing giving eighteen speeds from 35 to 1800 r.p.m., and nine feed rates. Whilst machining is in progress all the slides are locked by hydraulic means. All the principal motions have rapid traverse drive for quick setting.

The mechanism for automatic co-ordinate setting is enclosed in a cabinet at the side of the head. Through this mechanism the longitudinal and transverse movements of the head are determined by the setting of drums with direct reading figures arranged in two indicators. These indicator drums each carry a series of length gauges, and when they are rotated to show the cumulative figures of the dimension required, the respective series of gauges are aligned. When the appropriate transverse or longitudinal head movement is engaged by depression of a button the built-up length of gauge bar serves as a step to locate the spindle accurately. Settings down to 0·0002in can be made using the selector mechanism.

If required a preselection equipment can be supplied with the machine so that all operations on a component can be automatically carried out in the correct sequence. With this equipment in use the spindle is automatically positioned ; the hole is then bored to the required size at the correct feed and speed ; the tool is then retracted and subsequent head repositioning and boring cycles automatically completed.

Société des Usines Motobloc

An interesting lathe made by the Société des Usines Motobloc, 88, rue des Vivants, Bordeaux-Bastide, France, and shown on the stand of the Société de Construction des Machines-Outils Automatiques, 29, rue de Sassure, Paris, is illustrated in Fig. 25. This machine, for work up to 100mm diameter by 100mm long, can be arranged for a fully automatic cycle or semi-automatic operation where the size and shape of the work does not lend itself to automatic chucking.

The machine is fitted with a sliding headstock, two vertical tool slides, and a four-tool turret, all of which are operated by a single camshaft at the rear. One of the two vertical tool slides is used for external machining and the other for boring, whilst the four tools in the turret which faces the headstock are used for end operations, such as drilling, facing, &c. An automatic thread cutting attachment can be fitted for screwing work internally or externally.

The headstock spindle has twenty-six speeds from 230 to 4300 r.p.m. in two ranges of from 230 to 2600 r.p.m. and 385 to 4300 r.p.m. Work up to 32mm diameter can be mounted in collets in the spindle and for larger work a chuck can be fitted on the threaded nose to take pieces up to 100mm diameter. This headstock is moved along the bed during the machining cycle by a cam through a system of levers, which can be set to give a maximum stroke of 110mm. A pneumatic cylinder mounted at the rear of the headstock actuates the collets or chucks for clamping and releasing the work. This pneumatic clamping can be arranged for automatic or manual operation. When automatic chucking is engaged the control valve of the cylinder is operated from the camshaft.

Each of the two vertical tool slides is operated by a cam through a system of levers and the ratio can be adjusted to give the required length of tool movement. The four-tool turret head is fixed to the bed of the lathe and its turret is indexed by a small auxiliary motor through the operation of contacts on the camshaft. The tool spindles can be arranged for stationary operation or to rotate during the machining cycle. Any required spindle can be driven at up to 8000 r.p.m. in the opposite direction from that of the work in the headstock.

The camshaft at the rear of the machine is driven by an auxiliary motor through a gearbox, and it is designed to give cycle times from five seconds to eight minutes. It carries cams 250mm diameter for normal work and the ratio of the cam/tool movement is varied by adjustment of the transmission lever systems.

Two primary shafts in the gearbox transmit the high and the low-speed ranges respectively to the headstock spindle through electro-magnetic couplings. During a machining operation any required speed can be selected and engaged through contacts actuated by the camshaft.

Schiess A.G.

The largest machine shown on the stand of Schiess A.G., Dusseldorf, Germany, was a large precision gear hobbing machine (Fig. 26), which is made in a number of sizes. The smallest of these machines has a 71in diameter table and is designed to produce gears from 1in to 110in diameter, whilst the largest with a 173in diameter table is capable of cutting gears from 39in to 276in diameter.

The machine has a massive base which carries the rotating work table and supports a bed along which the main column is carried on large slideways. The table runs on an annular track, and a counterbalance and lever system is provided for load compensation on the ways when heavy components are mounted on the table. Table indexing drive is through a large master worm wheel driven by two worms, one on each side, and provision is made for independent adjustment of these worms to eliminate backlash. When the machine is used for hobbing, the table is driven from the main motor through change gearing, and when cutting teeth by single indexing a separate motor drive is used. The table can be rapidly rotated when setting.

On all machines of this design the column is traversed along its bed when cutting worm gears. through gearing giving a range of eighteen feeds

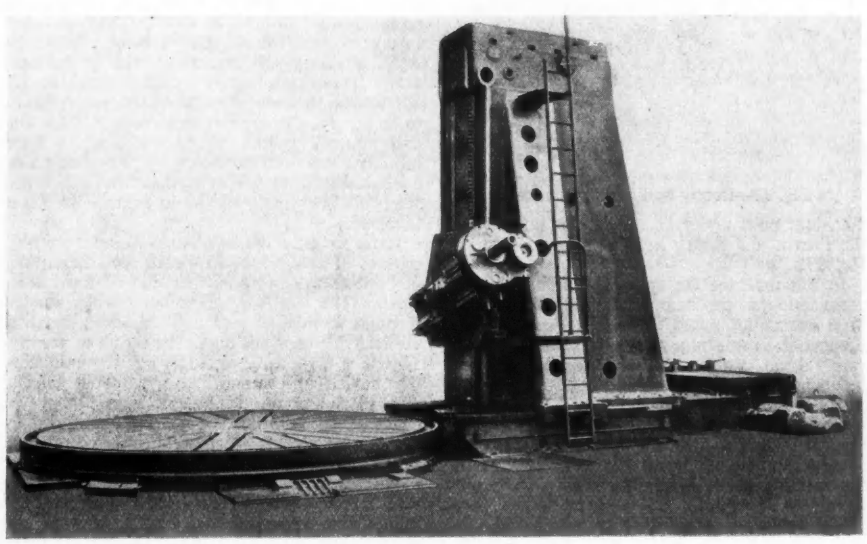


Fig. 26—Large gear hobbing machine

from 0·0031in to 0·1575in per revolution of the table. The hob saddle is traversed vertically on the column by an accurate lead screw giving a range of feeds from 0·0063in to 0·3150in per revolution of the table when hobbing or per revolution of the cutter when single indexing. The swivel head with the hob spindle has a cavity of ample size to accommodate large-diameter mills and fly cutters, and has an angular adjustment through more than 180 deg. This adjustment is made with reference to a graduated scale and vernier reading to an accuracy of 20 seconds. Hob spindle speeds from 6 to 68 r.p.m. are available and the spindle is driven through bevel and spur gearing on the standard machine. If required, a swivel head for particularly high-precision work and which has a worm drive to the spindle can be supplied.

Amongst the attachments available with the machine is a worm gear hob saddle for producing large lead worm wheels by tangential feed. The gearing in this saddle provides a tangential cutter feed dependent upon table motion and gives the additional table movement through a differential. End mill attachments are also provided for cutting external and internal gears, and a reversing gear can be used for the production of double and triple helical gears in one cut. A shaving attachment can be fitted on the hob slide for fine finishing without removing the work from the machine.

A new vertical boring machine shown by the firm was fitted with an electro-hydraulic automatic cycle control mechanism for the vertical and side heads. With this mechanism all slide movements are predetermined by the setting of stops and the cycle preselected by the setting of switches. A hydraulic profiling attachment is also fitted to this machine.

C.V.A. Jigs, Moulds and Tools, Ltd.

The equipment exhibited by C.V.A. Jigs, Moulds and Tools, Ltd., of Brighton, included single-spindle automatics from ¼in to 1¼in capacity, a toolroom lathe and a high-speed dieing press. One of the Kearney and Trecker

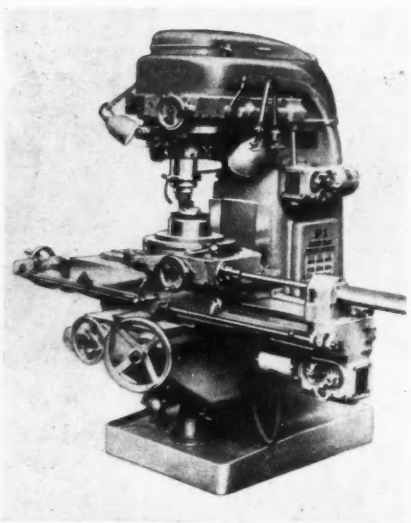
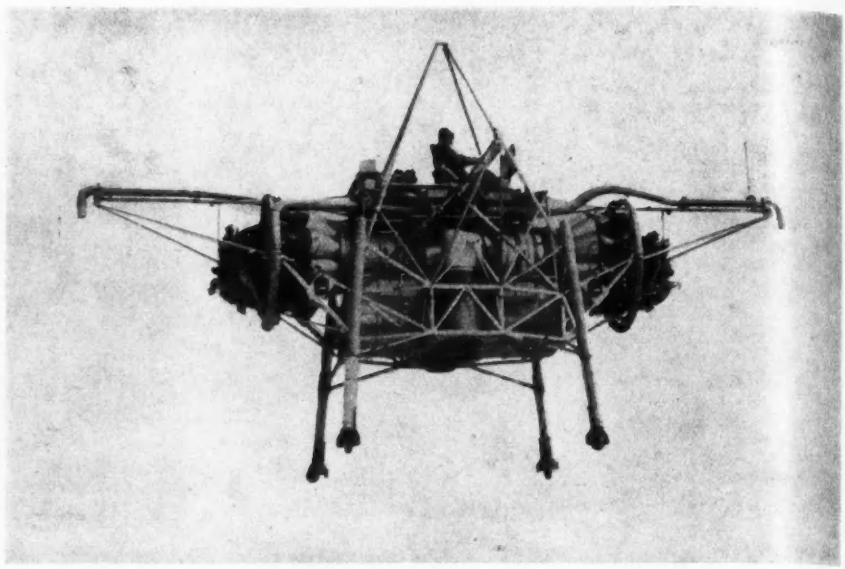


Fig. 27—Rotary head milling machine

machines built under licence in this country by the firm is the rotary head milling machine in Fig. 27.

In this machine the spindle is mounted on a cross slide that can be offset radially and rotated in a horizontal plane through 360 deg., while the spindle is rotating. Both the spindle and the rotary head can be rotated in either direction independently of each other. The spindle has a range of speeds from 210 to 3300 r.p.m. and over its 3in vertical adjustment has eight feed rates from 0·0002in to 0·008in per revolution. The spindle can be offset up to 4in from the centre of the rotating head, which has sixteen feed rates from ⅛ to 2½ r.p.m.

The table has a working surface of 36in by 16in and has both hand and power operation over a longitudinal travel of 24in and a transverse travel of 12in.



A rig sustained in flight purely from the vertical thrust of two turbo-jet engines. Inclining the rig by the thrust outriggers creates a thrust component for horizontal movement

Vertical Take-Off Research Rig

The prospect of launching an aircraft vertically using only the engines provided for its level flight requirements, has been brought much nearer reality in recent years by the rapid evolution of the gas turbine. Since the Whittle "W.1" engines of less than 1000 lb thrust, the specific thrust has been raised from about 1·5 lb per pound weight to that of nearly 4 lb per pound weight in the latest turbo-jet engines in the 10,000/15,000 lb thrust category. These increases have also been achieved without diametral growth. An aircraft with two such engines mounted in the fuselage, could therefore be designed with sufficient thrust to accelerate vertically from rest.

One of the principle problems in such an airframe is that of obtaining initial vertical control from surfaces designed to respond to the very much higher forward speeds of the machine. An illustration of an American machine in this category is shown on page 468. It is believed to have a coupled turbo-propeller engine developing almost 10,000 s.h.p. for a weight of 5000 lb. It will be seen to have vertical and dorsal tail fins. The physiological problems of such an arrangement can also be realised.

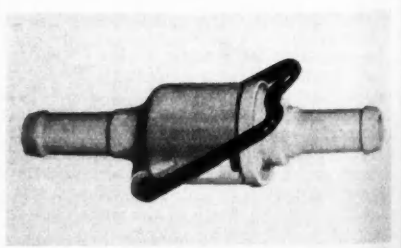
In this country what would appear to be a fundamentally different approach is illustrated by the research rig shown in our illustration which was built by Rolls-Royce, Ltd., for the Ministry of Supply. It is aptly named a "flying bedstead." As can be seen, the engines are mounted horizontally and the efflux is ducted to give vertical thrust, control being effected by small auxiliary jets operating with a moment arm. These presumably would incline the rig and impart to it a horizontal reaction component from the jet. An aircraft employing this ducting and control system would therefore achieve initially a near vertical take-off without assuming a vertical attitude. This rig has been developed solely to investigate the basic control problems involved.

It is powered by two Rolls-Royce "Nene" engines of about 5000 lb thrust, set horizontally in opposition, one on either end of the framework. The jets from these engines are ducted through 90 deg. so that both engines discharge vertically downwards under the centre of gravity. This is a favourable arrangement for balancing the device and eliminates gyroscopic effects. The pilot sits on a platform above the two engines. The control moments are supplied by compressed air jets which are discharged through nozzles at the ends of cross arms which can be seen clearly in the illustration. The air for these nozzles is bled from both engines and the pilot, using a conventional control column and rudder bar, regulates the flow through the nozzles. In this way the necessary pitching, rolling and yawing moments are obtained. In the initial tests, in order to safeguard the machine and the pilot, the "flying bedstead" was tethered to allow it only the limited freedom of a few feet of movement. With increasing experience and confidence the freedom permitted was increased. On August 3rd all check wires were removed and the machine took-off at Hucknall for the first time in free flight. It remained airborne for nearly ten minutes and during this time it moved about over the ground under the pilot's control at heights of from 5ft to 10ft, returning finally to alight at its starting point. For subsequent flights it has been flown free at heights up to 25ft.

Self-Sealing Air Hose Coupler

A new air hose coupler now being produced by Victor Products (Wallsend), Ltd., of Wallsend-on-Tyne, Northumberland, is designed for high and low-pressure airlines. It incorporates a rubber seal ring with a simple action. When the stem of the coupler is inserted into the spud and the air is turned on, the pressure causes the rubber ring on the stem to "rock" forward giving the initial sealing action. As the air pressure is increased so the sealing action is completed.

The coupler requires no spanners or tools to couple or uncouple, and it cannot be uncoupled whilst under working pressure. Additional safety is given by a spring bridle which holds the



Self-sealing air hose coupler with a spring bridle which holds the parts together, and allows the stem to be rotated to remove kinks and twists in the hose

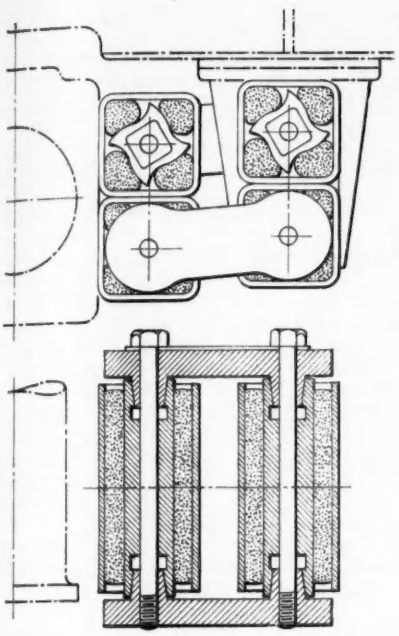
two parts together, and this bridle allows the stem to rotate within the spud so that kinks and twists in the hose can be removed. The rubber sealing ring, which is completely protected from damage and has a long life, is simple to replace, if necessary.

The couplers are being manufactured to cover hose sizes of ½in, ¾in and 1in both for hose-to-hose or compressor-to-machine connection.

The coupler stem is manufactured in three forms, whilst seven forms of spud fittings are available. One form of coupling can be seen in the illustration above.

Rubber Suspension for Railway Coaches

TRIALS are being carried out by British Railways with the Andre-Neidhart system of suspension on railway coaches. This system of suspension is made under licence in this country by the Andre Rubber Company, Ltd., Surbiton, Surrey, and can be seen as adapted for railway stock in the illustrations below. It consists essentially of four round rubber shock-absorbing members inserted in the pockets formed



Rubber shock-absorbing members adapted for railway carriage axle box suspension

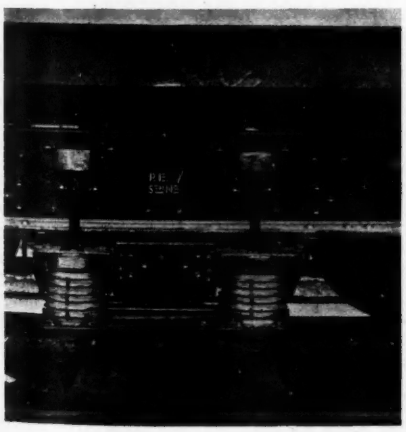
between the corners of an outer casing and the sides of a central shaft member. As can be seen from the drawing, in this particular construction the sides of the shaft are curved, and when the unit is in the unloaded state the rubbers are slightly compressed

In operation, when loads are applied, relative movement between the shaft and casing tends to turn the rubbers, which are further compressed. The profiles on the curved sides of the shaft are such that the resistance to torque is relatively high during initial movement and builds up steadily with progressive movement. On the load being released the rubbers return the parts to their original position without shock.

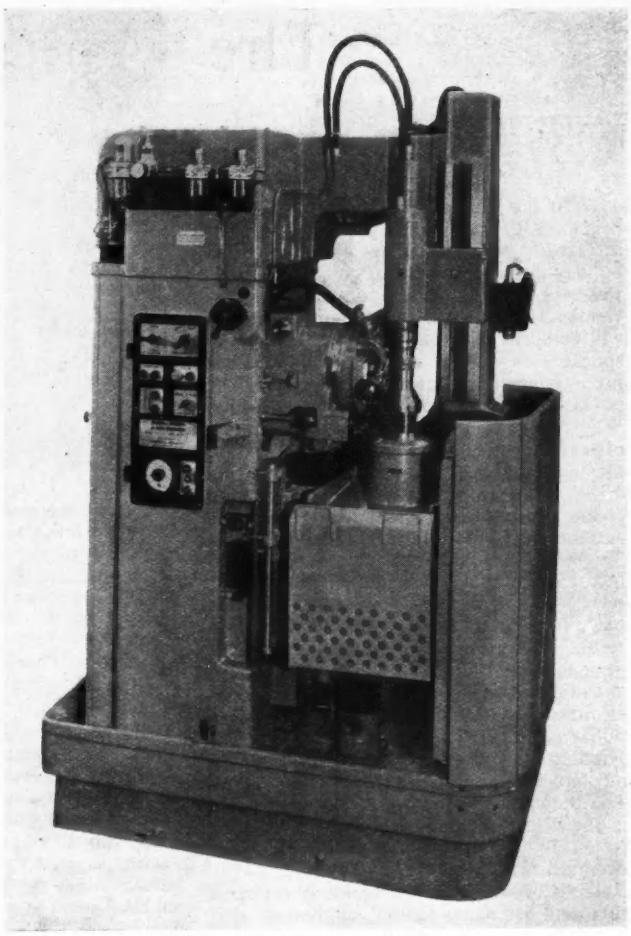
In the initial experiments with the suspension, British Railways have adapted it to replace conventional horn guides, axleguards, elliptical springs, &c., at the axlebox. It will be seen that in the suspension adopted a pair of casing members is fitted to each side of the axlebox with corresponding casings fixed in brackets on the bogie frame. The shafts of the two pairs of suspensions are coupled by means of heavy links with square spigots which register in holes in the shaft ends. On the two double-bolster standard bogies converted the outer helical springs were also replaced by rubber compression springs. With this form of construction the attachment of the wheel and the axleboxes to the bogie frame is entirely through rubber and there is no metal-to-metal contact.

The coach to which the bogies have been fitted has already been subjected to satisfactory preliminary trials, the tests having been made with a standard corridor composite coach. The trials indicated that improved vertical riding would be achieved by the fitting of a much stiffer suspension than was usual with the conventional arrangement, and that the transverse cushioning effect was also likely to give improved riding qualities. The suspension also eliminates a certain amount of wheel/rail joint noise due to the sound-insulating effect.

Trials are still continuing and a coach fitted with the suspension is now on a main line passenger train so as to build up mileage to ascertain the true dynamic effect on the rubber and evaluate its life. We are informed that new designs are being prepared for an all-rubber bogie suspension, including rubber units at the axleboxes and bolster, and also the fitting of rubber bonded to metal swing links. This, it is claimed, will eliminate all wearing surfaces and that the new links will be effective as bolster transverse return units, movement being taken through the rubber in shear. British Railways are also considering the production of two further bogies incorporating these designs.



Rubber compression springs on outer bolster used in conjunction with Andre Neidhart axle box suspension



Gear and spline-hobbing machine with continuous axial traverse hob head

Gear and Spline-Hobbing Machine

AN illustration on this page shows the latest design of Churchill-Cleveland "O-cycle Rigid-hobber" made by Churchill-Redman, Ltd., of Newcastle upon Tyne, for hobbing gears and spline shafts at both conventional and high speeds and feeds. These machines are made in four sizes each for work up to 8in diameter and with a maximum diametral pitch capacity of 4in in cast iron or steel. Two of the machines with a travel length of 8in have a maximum height from the work spindle to the tailstock centre of 28in and 49½in. The other two machines with a 16in travel have maximum heights of 37in and 43½in, respectively, from the work spindle to the tailstock centre.

In the new machines the hob is fed into the work by hydraulic power and the rate of hob feed and is infinitely variable from 0·04in to 1·8in per minute. Hob speeds of 70 to 500 r.p.m. are available. Vertical feed of the work is obtained by movement of the work slide which is guided on ways on the column and also on the box section over-arm. The vertical cutting feeds range from 0·006in to 0·25in per revolution of work, and for plunge or infeed hobbing, the vertical feed can be cut out.

The machines are fitted with the maker's continuous automatic axial traverse hob head, giving a gradual, continuous axial travel to the hob spindle while cutting is in progress so that the wear on the hob is distributed uniformly over all the teeth. For infeed hobbing with single position hobs, as used on camshaft gears, a special non-traversing head can be supplied.

Movement of the hob towards the workpiece is controlled by a stop which has micrometer adjustment. For infeed hobbing the hob slide dwells when the hob has plunge-fed to full depth, to allow the teeth to be generated. The period of dwell is controlled by a synchronous motor timer calibrated in one-second intervals up to 100 seconds.

The machine can be set up for automatic operation so that when it has been loaded and the start button pressed it completes the cut, returns to the start position and stops ready for unloading. Hydraulically-operated tailstocks, such as that shown in the illustration, and work-holding devices can be fitted and operated as an integral part of the machine cycle if required.

ATHLONE FELLOWSHIPS.—The Commonwealth Relations Office has announced the arrival of thirty-six Canadian engineering graduates to spend two years in the United Kingdom doing post-graduate studies, either in industry or at one of the universities. They are the fourth party of Canadians selected for Athlone Fellowships. Four years ago, the Athlone Fellowship Scheme was evolved in response to the desire of British industry to encourage promising young men to come from Canada to study engineering techniques and equipment. Under the scheme, which is financed by the Government in conjunction with industry, thirty-eight candidates are selected for fellowships each year by the Canadian University authorities, assisted by United Kingdom representatives. The first party returned to Canada at the end of their training last year; the second party, who came in 1952, will be returning later this year.

The American Scene

(By Our American Editor)

COLOUR TELEVISION

WITH the Columbia Broadcasting System beginning to transmit its popular "Toast of the Town" variety show in colour on a recent Sunday evening, the era of colour television was said to have come upon the American viewer. From now on, millions of dollars will be spent by broadcasting networks and sponsors to put on upward of 100 colour programmes this season, whereas now the public can see them only in black and white. Why ? One reason is that the manufacturers of television picture tubes and receivers are playing a publicity game instead of getting down to the practical business of making colour receiving sets for the market. The current battle for publicity is an intensely-fought game in which the players, or manufacturers, outbid one another with press releases about the new developments taking place in their respective laboratories. As a result, nobody makes colour tubes for the poor television fan, who would love to have a colour receiving set at a price he could afford to pay. Unfortunately for the viewing public, the manufacturers are too busy grinding out press releases and scrapping incompleted projects in their laboratories. The ridiculous situation which has arisen in the field of colour television can be illustrated by a sequence of events that has occurred this year. On March 25th the Radio Corporation of America, the largest tube and set manufacturer, announced that it would start production of a 15in colour tube and produce 10,000 sets by the end of the year. It also said that production would begin later in the year on a 19in tube. The bidding stepped up on April 28th, when the Allen B. Du Mont Laboratories, Incorporated, demonstrated a 19in tube on a closed circuit. But on July 8th, C. B. S.-Hytron, the tube manufacturing division of the Columbia Broadcasting System, demonstrated its 19in tube that had a slightly larger picture area than the one introduced by Du Mont. A week later, on July 14th, R.C.A. suddenly moved to top all the previous bidding by exclaiming that it had developed a 21in tube. The hurried announcement seemed a little premature, however, in the light of the company's statement that the tube would not be demonstrated until two months later. It would have been only natural if the harassed American set makers, pondering which tube to place orders for, decoded the R.C.A. announcement to imply "Don't do anything until you hear further from us !"

Because of the confusion and indecision on the size of tubes, whether they should be round or rectangular and have one colour gun or three, mass production is still non-existent. The Radio Corporation of America started to make colour sets ahead of everyone else, but is not in commercial production at all at the present time. It did turn out a few thousand 15in receivers, but gave up on that model more than two months ago. Presumably the company also has discarded its earlier plans for a 19in tube because of its forthcoming 21in model. But whatever its production plans for the bigger tube, they will not be announced until later on this month. These events clearly indicate that the American television tube and set manufacturing industry has made the mistake of trying to fly off in all directions instead of charting a course. Admittedly it takes time to start the assembly lines rolling to turn out colour sets, but how long is the industry going to dawdle ? How much time and money will be wasted in blind, ill-fated research projects before manufacturers wake up to the fact that there can be no beginning of mass production until the members of the industry agree on what size tube and general standards will best serve, initially at least, a public demand ? The industry might well recall the words of one of its own leaders, Dr. W. R. G. Baker, vice-president of The General Electric Company, who said last April in a talk on colour problems : "If the proponent of each type of colour tube takes the position that he can lead the industry out of the wilderness of confusion, then perhaps we have too many leaders. As a result, the industry actually is leaderless and will remain so until, by costly experiment and perhaps many mistakes, it achieves the standardisation in tubes and circuitry which it enjoyed in monochrome in 1946."

One thing that manufacturers are worried about is the initial high cost of colour sets, both to themselves and to the consumer. Obviously the only way to overcome high costs is to turn out receivers on a mass production basis, so one may wonder why the industry does not set up more ground rules enabling it to go ahead. Despite the highly competitive factors involved, there will be enough business for all manufacturers once colour sets are made available at the right price. Actually, there was no point in the 15in colour set ever being put on the market. Its picture area was far too small to win acceptance by the American public, which now looks upon a 19in or 21in screen as being standard in black- and-white receivers. Since 19in colour tubes have been successfully demonstrated already, and since a 21in tube is claimed to be on the way, what reason is there for the industry to procrastinate any longer ? There may be some manufacturers who prefer not to go into production until the design of sets reaches a higher state of perfection. But this does not mean that sets of good quality cannot be turned out now. Many engineers think they can. Also, all the "snags" in colour receiver circuitry will never be removed in the laboratory. The development of the black-and-white receivers has shown that many of the advancements must come from putting sets to practical use. Is it possible that the television industry has forgotten the fussing, feuding and fighting that went on in the battle over colour standards, which finally was amicably resolved when the manufacturers got together and agreed on a compatible system ? It is to be hoped that the members of the industry will soon show similar statesmanship to settle the current wrangling over screen sizes, thus removing the one major obstacle which is still preventing the mass production of reasonably priced colour receiving sets.

Pressurised Water Reactor for Electric Power Generation

Last year the U.S. Atomic Energy Commission authorised the Westinghouse Electric Corporation to develop and design a pressurised light water reactor and a primary coolant circuit intended as the heat source for generating civilian electric power. In April last, the Commission announced that this first large-scale American atomic power plant would be built in co-operation with the Duquesne Light Company at a site on the Ohio River near Shippingport, Pennsylvania. The power station is expected to produce at least 60MW of useful electric energy and will utilise turbo-electric generating equipment of conventional design.

IN July, 1953, the Westinghouse Electric Corporation, of Pittsburgh, Pennsylvania, was given the responsibility by the U.S. Atomic Energy Commission for the development and design of a pressurised light water reactor ("P.W.R.") and a primary coolant circuit intended as the heat source for generating civilian electric power. In October, 1953, the A.E.C. formally announced the award of this contract to Westinghouse and, at the same time, invited American industry to propose ways and means whereby it might participate in the project and help defray the costs involved. In March of this year, following the receipt and analysis of nine proposals, the Commission announced that an offer made by the Duquesne Light Company, of Pittsburgh, Pennsylvania, was most favourable to the U.S. Government and would be accepted. The offer stipulated that Duquesne would furnish a site for the entire "P.W.R." project, that Duquesne would build an electric generating plant, that it would contribute 5,000,000 dollars toward the cost of the reactor plant, and that it would operate the overall plant at no cost to the U.S. Government. In addition, Duquesne will purchase steam produced by the reactor plant at certain specified rates which vary from 48·3 cents per million B.Th.U. during the first year to 60·3 cents per million B.Th.U. during the fifth year.

On April 12th last, the Atomic Energy Commission announced that this first large-scale atomic power plant would be built near the village of Shippingport, Pennsylvania, on the south bank of the Ohio River about 25 airline miles from Pittsburgh. The ground breaking ceremony, in which President Eisenhower participated, took place on September 6th. An aerial view of the site selected is reproduced in Fig. 1. The following general specifications were given to the Westinghouse Electric Corporation at the beginning of the present scheme :—

(1) Generation of at least 60MW of useful electric energy.

(2) Use of a light water cooled and moderated, slightly enriched uranium reactor.

(3) Use of steam conditions of 600 lb per square inch absolute, saturated or higher.

(4) Fuel element life to be as long as possible between chemical reprocessing.

(5) Refuelling to involve only a minimum shut-down period.

(6) Conventional central station steam, electric and auxiliary systems to be employed.

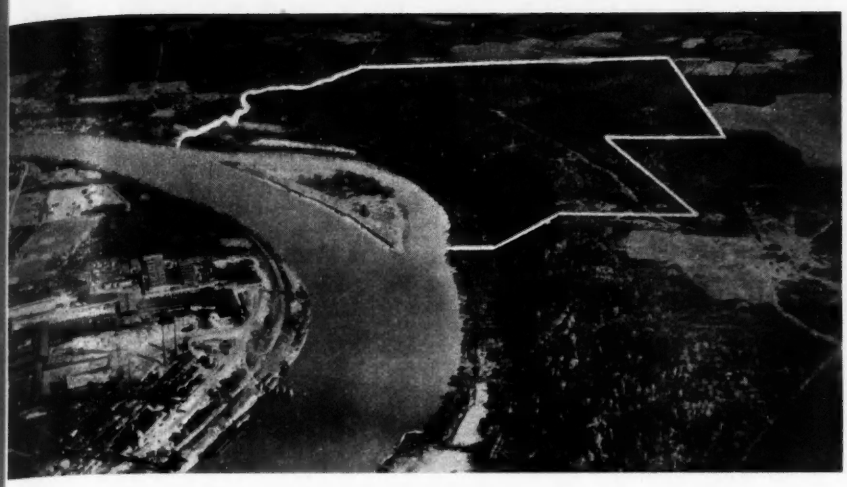


Fig. 1—Aerial view of site selected for pressurised water reactor near Pittsburgh

At the initial stage of the present scheme, the company felt that the most serious problem concerned the development and design of the nuclear core. The two major aspects of this problem involved the development of suitable materials for the reactor and the development of basic design data and relationships capable of being used to calculate the nuclear design of the reactor core. Up till last year, the company knew of no fuel material having corrosion resistance characteristics and radiation stability which showed promise of meeting the conditions laid down in the specifications. It was therefore decided to give priority to the production, testing, and study of many potential fuel materials. A considerable effort went into the development of suitable structural materials and the fabrication of fuel into various shapes. An extensive "in-pile" test programme was established for testing both sample materials and sample fuel elements. This work involved the design, fabrication, and installation of several high temperature, high pressure test loops for use in the Canadian nuclear reactor at Chalk River and the Materials Testing Reactor (" M.T.R.") at the National Reactor Testing Station in Idaho. The bulk of the effort in the field of reactor design was aimed at developing information necessary to choose a fuel element shape and to establish the thermal design of the reactor. This programme involved preparing a number of different core designs associated with various fuel elements. It involved heat transfer studies to develop the basic data required to prove the design ; and, in this respect, use was made of a special fuel element burn-out test loop. In addition, preliminary designs were made of the primary coolant system, including a determination of the number and size of the primary loops required, the methods to be used in constructing individual components, and the preparation of specifications for items requiring extended deliveries.

Primary Coolant System

The basic design of the " P.W.R." plant has now been established, in keeping with the general specifications laid down by the U.S. Atomic Energy Commission. The main coolant system, which serves both to absorb heat generated by the reactor and to deliver heat to the steam generators, will consist of four loops operating off the reactor vessel, as shown in Fig. 2. Each loop, in turn, consists generally of a pump, a steam generator, shut-off valves and inter-connecting pipework. The pumps continuously circulate coolant water between the reactor and the steam generator. The steam generator is the connecting link between the primary system and the steam system. It consists of a water-to-water heat exchanger and a steam drum and separator. The shut-off valves permit the operators to isolate one loop if it is not required, or to repair one loop while the other three loops are operating. The water in the primary plant will circulate at a pressure of some 2000 lb per square inch to prevent boiling in the core and to eliminate cavitation problems. The average temperature of the primary plant water is maintained at about 525 deg. Fah.

The primary coolant loops have been designed so that the rated plant output is produced with three of the four loops operating. The fourth loop can be operated if desired, but will normally serve as a spare. The loops divide the load equally and the steam generated by each is fed to a steam header and delivered to the turbine. To produce a net output of 60MW with three loops operating, the pump in each loop has to circulate water at a rate of about 16,000 U.S. gallons per minute. About 1000 h.p. is required to circulate the water in each of the three loops. All surfaces of the primary plant which come in contact with high temperature primary coolant water will be made of stainless steel, and all components will be designed to prevent any leakage of the primary coolant water from the primary system. In addition to the main coolant system, the primary plant involves a number of auxiliary systems. These accomplish such functions as maintaining the primary system pressure at 2000 lb per square inch, filling and draining the primary system, purifying the water, providing for control of the reactor and dissipating the decay heat of the reactor after shut-down. The primary water is maintained at 2000 lb per square inch by a pressurising tank which floats on the system and is connected to one of the reactor outlet pipes. This tank is normally filled with about equal volumes of water and saturated steam at a temperature of more than 600 deg. Fah. The head of steam is maintained by electrical heaters in the water and any load changes are accompanied by some volume change of the primary water. The head of steam expands or contracts to accommodate this water volume change.

Design of Reactor

The reactor core to be employed in the plant will consist of a geometrical pattern of closely spaced fuel elements. The heat generating material will be slightly enriched uranium, i.e. uranium containing a slightly higher amount of the 235 isotope than natural uranium as mined from the earth. More than 10 tons of uranium will be used in the first core. The fuel elements will be protected by a corrosion-resistant material designed to prevent the coolant water from becoming contaminated with particles of uranium and fission products. These fuel elements will be formed into a right circular cylinder about 6ft in diameter and 7ft 6in high. The maximum fuel element surface temperature will be less than 636 deg. Fah., which is the boiling point of water at 2000 lb per square inch. The maximum heat flow will be over 350,000 B.Th.U. per square foot per hour, and the average power density will be about 45kW of heat per litre.

The reactor container, as well as the entire plant, is being designed so that fuel elements of various shapes and materials of various types can be used in cores following the first core. Such flexibility will add somewhat to the cost of the plant, but it is expected to help in advancing atomic power technology. The reactor vessel, which contains the core, will be built large enough to accommodate cores physically bigger than the first one. The vessel shell will be about 9ft in diameter and have an overall height of over 25ft. This shell will consist of carbon steel clad with stainless steel. The cylindrical wall of the vessel will be penetrated by the four inlet and four outlet pipe connections for the four main coolant loops.

Steam Generators

The steam generators will consist of two major components ; the heat exchanger portion and

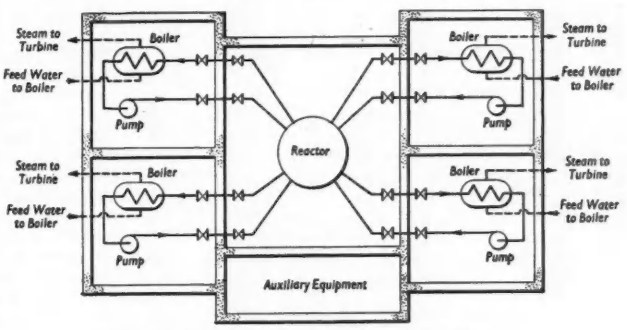


Fig. 2—Arrangement of primary coolant system

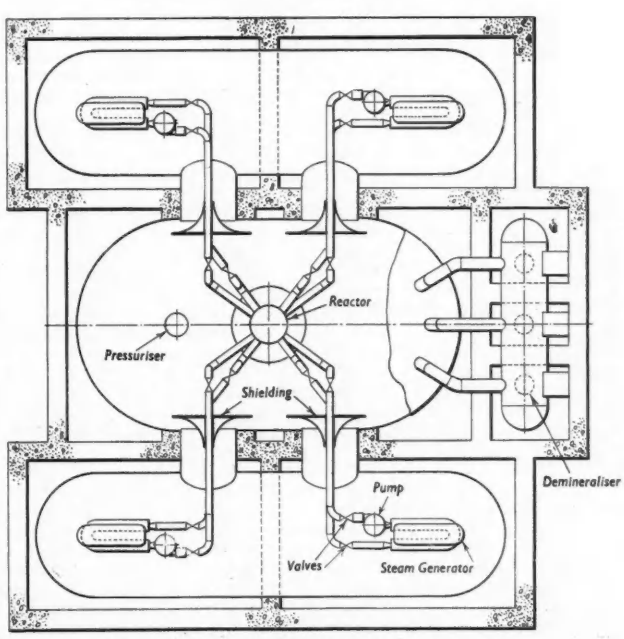


Fig. 3—Plan view of proposed primary plant layout

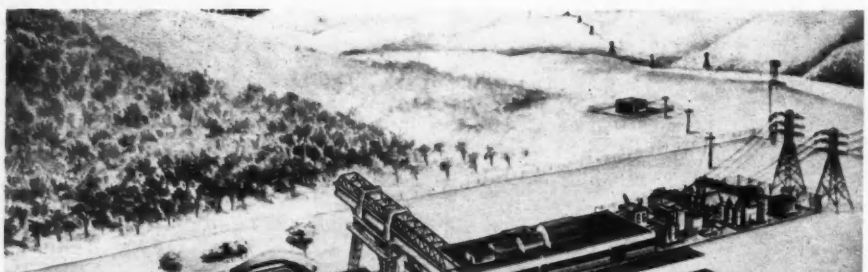


Fig. 4—Artist's impression of first American commercial nuclear power station, employing a pressurised water reactor

the steam drum. The heat exchanger will consist of a bundle of stainless steel tubes, the ends of which will be welded into heavy tube sheets. The entire assembly will be enclosed in a steel shell. Primary coolant flows through the inside of the tubes. The steam plant feed water will be fed into the shell side of the heat exchanger and will be converted to steam as it flows upward over the outer surface of the tubes. The steam thus generated will rise to the steam drum where it will be dried by passing through a conventional steam separator. The steam will leave the steam drum at a pressure of 600 lb per square inch absolute, in the saturated condition. Orders have now been placed for the four steam generators ; the Foster Wheeler Corporation and the Babcock and Wilcox Company will build two each.

The pumps will be single-stage centrifugal units driven by induction motors of " canned " construction. The use of such " canned " motors permits the elimination of the maintenance and leakage problems likely to be encountered if rotating seals were employed. The Atomic Equipment Department of Westinghouse is now designing a prototype pump and motor which will be built and tested before manufacture of the final units. The pumps required will involve an output of about 1000 hydraulic h.p., and an input of about 1200kW. The primary coolant stop valves will be of the gate design. At least some of these valves will be designed to permit remote operation. They will be hermetically sealed and will function hydraulically. The pipe to be used in the primary coolant system will be approximately 18in in outside diameter and will be fabricated from stainless steel.

Regarding the nuclear control of this plant, the designers intend taking advantage of the inherent stability of pressurised water reactors as the basis for control during power changes. Due to the negative temperature coefficient which can be designed into such a reactor, the core will automatically maintain the temperature of water flowing through it at a constant value. Thus, if heat is removed from the primary coolant and if the coolant water temperature therefore decreases, the reactor automatically restores this heat by increasing its power output until the water temperature regains the original value. The reverse is true when the rate at which heat is being removed from the primary water is decreased. The reactor itself accomplishes this control automatically without the operation of any equipment.

The entire primary plant will be enclosed in a steel container to retain any radioactive materials which might escape from the plant as a result of an accident. Although such accidents are extremely improbable, the prevailing safety requirements are such that, at least on this first plant, great precautions must be taken. Fig. 3 shows a plan view of the proposed layout for the primary plant and the major plant components including the reactor, the pipe, main coolant pumps and the steam generators. Fig. 4 shows an artist's rendering of the overall plant. The plant components depicted are from the left : a building for fuel handling, the atomic reactor and heat exchangers, the maintenance building and overhead travelling crane, the turbo-generator building, the switch-yard containing transformers and circuit breakers and transmission lines. In the right foreground is a building containing shop and administrative buildings. As can be seen from the cutaway view, the reactor which provides the heat and the heat exchangers which generate the steam, will be situated underground in concrete and steel structures.

Because of the high cost of enriched uranium, it was decided to employ uranium of the least enrichment consistent with other technical considerations. Similarly, heavy water is expensive, and its limited advantages, in the opinion of the designers, do not offset the extra cost ; hence they chose to use ordinary water. Fuel reprocessing is expensive and therefore the design is aimed at the longest attainable life span for each core loading and, in addition, it is hoped to make the maximum use of converted material. This objective calls for a high rate of fuel burn-up including a burn-up of the plutonium produced as the reactor operates. The " P.W.R." will be a converter, i.e. it will convert fertile material to fissionable material in the core. It is expected that as more knowledge is obtained regarding reactors of this kind, more and more of the power will come from burning the plutonium generated in the reactor after operations commence.

Ultrasonic Cleaner for Precision Components

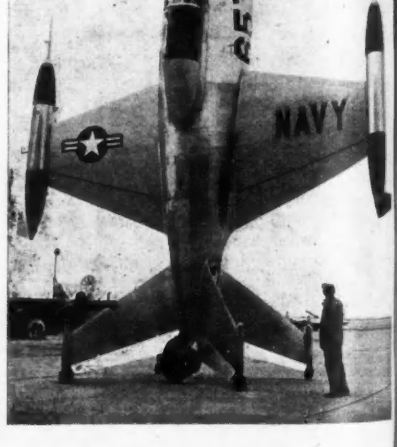
THE Pioneer-Central Division of the Bendix Aviation Corporation, in Davenport, Iowa, is now producing commercially an ultrasonic cleaner for processed components. The device, which is known as the Bendix ultrasonic cleaner, operates with either water-soluble detergents or cleaning solutions and employs a low-frequency, magnetostrictive transducer. The ultrasonic energy forces the solution to cavitate, or " cold-boil," with the formation of countless minute bubbles. These bubbles implode and blast particles of grease, grit and other foreign matter loose. The cleaner is being produced in diameters of 4in, 7½in and 12in, each with a depth equal to its diameter. The three models have been designed to fit the needs of a broad segment of the precision products industry, such as manufacturers of bearings, optical lenses, watches and timing devices, business machines, control mechanisms, and sensing instruments. Developed originally to meet the company's own needs in cleaning miniature bearings for high-speed gyroscopes, aircraft oxygen system components, watch-size gear trains, and other finely machined and lapped products, the new cleaning device consists of two basic parts : a cabinet, or " generator," housing vacuum valves and electrical circuits and the transducer, or cleaning unit, which holds the cleaning solution and converts electrical energy from the generator into ultrasonic vibrations.

The cleaner has been in use on a production basis at the works of the company for more than fourteen months, achieving savings of up to 75 per cent in direct labour costs for cleaning precision parts and in some cases cutting solvent costs as much as 98 per cent. It was found that in the application of ultrasonics to industrial cleaning certain frequencies were more effective than others. In the cavitation process the lower frequencies tend to " wrap around " the parts being cleaned—penetrating even blind holes and mechanical interstices which not only resist all other methods of industrial cleaning, but also defy the higher frequencies of ultrasonic energy. The higher frequencies tend to act like a beam of light and " bounce off " in contrast to the " wrap around " action of the lower frequency used in the present device.

Radioactive isotopes were used in a recent test at the Davenport laboratory of the company to obtain an interesting comparison of ultrasonics and other methods of cleaning. The test consisted of incorporating the radioactive material into an insoluble buffing compound, which was then baked on stainless steel cylinders for four hours at 400 deg. Cent. Each of the six cylinders then was cleaned by a different process and again checked for radioactivity. The contamination removed by each of the six processes, as checked by a Geiger counter, showed these results : pressure washing, 14 per cent ; agitated immersion, 30 per cent ; vapour degreasing, 35 per cent ; tumbling, 85 per cent ; and ultrasonics, 99·5 to 100 per cent.

Vertical Flight

THE U.S. Navy recently released a first photograph of the " XFV-1 " fighter aircraft, which has been developed by the Lockheed Aircraft Corporation, of Burbank, California. The photograph, which we reproduce herewith, shows the aircraft prior to taking off vertically. Powered by twin gas turbines driving counter-rotating propellers, the " XFV-1 " can take off vertically from a standing start on its tail, level off to fly and fight at very high speeds, hover stationary in the air and descend for a landing by backing straight down. The aircraft uses its four-pointed, X-shaped tail for a landing gear. A specially designed ground handling cart is used to lift the aircraft into its vertical take-off position. It also provides a ladder for the pilot to climb up and step sideways into the cockpit.



U.S. Navy fighter aircraft " XFV-1 " prior to vertical take-off

Industrial and Labour Notes

British Productivity Council's Progress

The British Productivity Council has published a progress report which surveys its activities during the first eighteen months or so of its existence. The Council's programme, it will be recalled, was outlined and discussed at a conference in London in March, 1953. The programme, it was then explained, had been based on the experience gained by the Council's predecessor, the United Kingdom section of the Anglo-American Council on Productivity. The primary point in the British Productivity Council's programme is the benefit to be gained by employers and trade union leaders getting together with the common object of increasing productivity and efficiency in industry.

The principal part of the Council's work so far has been the establishment of local productivity committees. In Great Britain ninety-four of these committees have now been set up, consisting of members drawn from both sides of industry, together with representatives of professional organisations and technical and educational institutions. Alongside the establishment of these local committees, the Council has been developing its "circuit scheme," the aim of which is to spread more extensively the knowledge and experience that are to be found in British industry. Under arrangements made by the local productivity committees firms pay visits to, and receive them from, other firms in their area. The visiting teams are small and are drawn from managements, technicians and operatives. These teams do not merely visit firms in their own industry, and nor do they look only for devices and methods which can be directly transferred to their own production lines. The report says that more than 500 firms, employing over 500,000 workers, have already joined the circuit scheme.

A more recent activity mentioned in the report is the formation by the British Productivity Council of a work study unit. The main purpose of the unit is to encourage critical examination and appreciation of the possibilities of increasing productivity by adopting improved methods. It will not, of course, enter into questions concerning wages or conditions of employment, nor will it invade the field of bodies which provide full-length courses of instruction or technical guidance to individual firms.

European Productivity Agency

Rather more than a year ago, the Organisation for European Economic Co-operation established the European Productivity Agency. The Agency published its first programme of work in January last, and this has now been followed by a second programme. This programme urges the study of problems relating to industry and commerce, problems relating to agriculture, and also what are described as "common problems." In devising its programme, the Agency says that it has kept in mind certain key factors, the first being that Europe will not be able to rely for ever on aid from the U.S.A., so that a European programme must be developed on a self-help basis. Another factor is that an increase in productivity in any sector implies the adoption of newer techniques, which, in turn, requires a change in attitude of both management and labour. The Agency adds that training methods have to be improved and more use made of modern techniques of instruction, so that human skill will keep pace with technical progress.

Dealing in its programme with labour problems in industry, the Agency says that no policy of increased productivity will succeed unless the atmosphere within the undertaking is good. Many studies have been made of the physiology and psychology of work, the Agency comments, but too often the knowledge gained has not been applied, owing, it is claimed, to the absence of contact between the academic and the business world. The Agency hopes to bring the two sides closer together by employing specialists to train groups of instructors who will in turn train people in their own countries. The programme includes projects for disseminating information on problems connected with the adaptation of the job to the worker and about questions related to fatigue and material conditions of work. The Agency also emphasises the importance of applied research in industry. In this sphere its aims are to pool experience and knowledge concerning the human and material resources devoted to research in Europe; to foster the use of more efficient methods of organisation and administration in research; to ensure a more rapid and complete application of the results of research to production, and to promote liaison between government departments, academic institutions and industrial leaders.

Industrial Policy

In an address to the Institute of Industrial Administration at Manchester last Friday, the Parliamentary Secretary to the Ministry of Labour, Mr. Harold Watkinson, spoke about the industrial policy advocated by the Government. To-day, he said, civil employment was at the highest figure ever recorded in peacetime, unemployment was only 1 per cent of all insured employees, and there were more vacancies than there were people to fill them. In the last twelve months, Mr. Watkinson added, the biggest increases in employment had come in the engineering and vehicle industries, and record levels of production and productivity had been achieved.

Mr. Watkinson went on to say that increased productivity and efficiency must be split in three ways; first, to reduce prices; secondly, to increase earnings, and, thirdly, to increase profits and to plough back sufficient for re-equipment. Stability, he commented, implied a balance, and a balance could only be fairly achieved if all sides contributed something to it. As a nation, Mr. Watkinson asserted, we had shown that this crucial balance in our economy was within our grasp, and if it could be achieved, then there could be increasing earnings with stable prices. Put briefly, he continued, what was wanted in industry to-day was a "high output and high earnings" policy. The more a man earned from conscientious work, the better it was for him, for industry and for the nation.

Mr. Watkinson then went on to speak of the importance of encouraging industry to pioneer in the great advance in science and technology. The nation, he said, was capable of reaching still higher standards of output and efficiency to the mutual benefit of every one of its citizens. Turning to the responsibilities of management in industry, Mr. Watkinson observed that the trend of affairs in the past two years had demonstrated how well British management had done its work. There could, however, be no complacency in a world where trading conditions were becoming ever more fiercely competitive. Managements must recognise a responsibility for telling their workpeople about the activities and fortunes of their establishments, and the way these were related to wider economic issues. It should be the aim of every employer, Mr. Watkinson urged, to establish good systems of communication within his organisation, systems that worked both ways and which became the recognised and trusted channels for authoritative information.

Labour Costs

Some comments on labour costs in the engineering industry were made by Sir Harry Railing in his chairman's address at the annual meeting of The General Electric Company, Ltd., which was held in London on Thursday of last week. He said that in a great many products labour costs, including the labour cost of raw material produced at home, amounted to as much as 80 per cent of the cost of the product. Every 5 per cent advance in labour costs, therefore, might mean a 4 per cent increase in cost. That, Sir Harry asserted, showed the utter futility of the wholesale argument that the engineering industry could afford a general wage advance. What might be possible in one section, where labour costs played a small part, would be fatal in other sections of the industry.

Broadly speaking, Sir Harry continued, with the existing taxation, rate of plant renewals, hours of working and output per man-hour, general wage advances could only be met either by reducing the remuneration on capital or the money available for research, plant modernisation and new ventures. Either course would ultimately be fatal because we could not have a static economy; there must be a dynamic economy enabling industry to invest in progress. If any company or country tried to reverse that process, its economy would suffer.

Sir Harry also spoke about the importance of adequate profits. In this connection he said that the United Kingdom could not afford to limit its annual capital expenditure to £2300 million when the U.S.A. spent £9000 million. If the U.S.A. investment per head was taken as 100, the corresponding figure in Germany was 59, and in the United Kingdom it was 38. If that were to continue, Sir Harry observed, if profits after taxation were not adequate either to leave room for ploughing back or to attract outside capital, the only way left to compete with other countries would be by lowering wages, which nobody wished to contemplate. This, he considered, showed that labour had, to say the least, as great an interest as the other partners in seeing that adequate profits were made in industry. It showed the supreme importance of encouraging profits instead of discouraging them. Due attention, Sir Harry added, must be paid to the need for the overall profitability of a company's or an industry's activities. That applied equally to nationalised and to privately owned industries.

Northern Ireland's Industries

In an address, on Saturday last, to the annual conference of British Junior Chambers of Commerce, the Prime Minister of Northern Ireland, Viscount Brookeborough, said that if Northern Ireland was to contribute its full share to the welfare of the United Kingdom and the Commonwealth, the provision of increased opportunities for employment was essential. The Government had increasingly pursued the policy of stimulating the introduction of new industries and of encouraging established industries to expand. Although new factories were now employing thousands of workers, Northern Ireland still had far to go to achieve full employment. In August, the number of persons registered as unemployed was over 28,000, representing 6 per cent of insured employees. The population was expanding, and it was estimated that by 1960 the number of boys and girls available for employment would be 12,000 more than the number required to fill normal vacancies.

Last year, Viscount Brookeborough continued, the total trade of Northern Ireland was estimated at £496 million, imports being valued at £259 million and exports at £237 million. These signs of activity, he suggested, must convince manufacturers that there was nothing wrong with Northern Ireland as a location for industry. The Government, the Prime Minister stated, was still working to stimulate economic expansion and in the last twenty years or so 236 industrial undertakings had been started with Government assistance. The Ministry of Commerce had built twenty-three new factories since the war, and the total area which had been built or purchased by the Government for industry was approximately 2,000,000 square feet. Grants made towards new industrial undertakings had totalled about £1,300,000, and long-established industries had benefited from grants under the Re-Equipment of Industry Act to help them to get new machinery and equipment and thus increase their efficiency. In addition, Viscount Brookeborough said, the Government assisted both new and established industries by making grants towards the cost of coal, gas and electricity used for manufacturing purposes.

Notes and Memoranda

Rail and Road

SAFETY PROPOSAL FOR MOTOR VEHICLES.—The Minister of Transport and Civil Aviation has circulated to interested organisations a proposal that motor vehicles generally should be required to have two driving mirrors. One mirror would be fitted externally on the offside and the other either internally or on the near-side. This proposal follows recommendations made by the Committee on Road Safety, the Road Research Laboratory and other bodies. Only one mirror is compulsory at the present time, and a second mirror should reduce to a reasonable minimum a driver's blind spots. Motor bicycles and certain other classes of vehicles, which are not at present required to have a mirror, would still be exempt, but three-wheeled cars and vans, although legally classified as motor-cycles, would have to be fitted with two mirrors. The Minister also proposes to make it compulsory if a pillion passenger is carried on a motor bicycle for suitable foot rests to be fitted. Organisations have been invited to let the Minister have their comments on these and other proposals by October 31st.

INTERNATIONAL TRAFFIC CONFERENCE.—Representatives of the standing joint committee of the Royal Automobile Club, the Automobile Association and the Royal Scottish Automobile Club were among the British delegates attending the second international lecture course in traffic engineering, which was held at Burgenstock, Switzerland, last week. The object of the course, at which 300 traffic experts from nineteen countries were present, was to discuss road and traffic problems common to countries throughout the world. Over forty papers on eight main themes were presented; among them were papers on "The Design of Road Intersections and Interchanges"; "The Case For and Against the Three-Lane Road"; and "Parking: the Assessment of Present Needs, the Prediction of Future Needs, and Methods of Providing for Them." The course was organised by the World Touring and Automobile Organisation and the Permanent International Association of Road Congresses, with the co-operation of the International Road Federation.

Miscellanea

MR. D. R. A. PISTOR.—We note with regret the death of Mr. D. R. A. Pistor, which occurred suddenly, while on holiday in Scotland, on September 23rd. Mr. Pistor was a director of B.K.B. Electric Motors, Ltd., and was for nearly forty years the manager of the Hibbert Street works, Luton, of George Kent, Ltd.

DEWATERING FLOODED MINES.—According to *The Tees-Side Journal of Commerce*, the National Coal Board's scheme for dewatering flooded mine workings in the South-West Durham area may be completed by the end of this year. The scheme was put into operation four years ago. With the completion of the scheme, a total of about 70,000,000 tons of coal, which at one time it was feared might be a total loss, will have been freed and made available for working.

EXHIBITION OF CATALOGUES.—An exhibition entitled "100 Good Catalogues" is to be opened at the British Institute of Management headquarters, Hill Street, London, W.1, on October 12th, by Mr. Henry Strauss, Parliamentary Secretary to the Board of Trade. It has been organised jointly by the British Federation of Master Printers and the Council of Industrial Design, and will display 100 good catalogues chosen from more than 1500 submitted by British firms.

OFFICE MACHINERY EXPORTS.—The Office Appliance and Business Equipment Trades Association has stated that exports of British office machinery during the first eight months of this year were at a record figure of £8,184,994. The biggest increase was in the export of typewriters, which exceeded £2,100,000, or £800,000 more than in the same eight months last year. Office machinery sales to North America amounted to £1,602,149, and to Australia to £1,413,629.

SHELL HAVEN REFINERY.—A plant to produce and handle 10,000 tons of butane and propane-hydro-carbon gases is now under construction at Shell Haven oil refinery of the Shell Petroleum Company, Ltd. Large spherical tanks will store the butane and the propane will be stored in high-pressure, long cylindrical vessels. In addition, a bottling plant is planned for handling propane, while bulk loading facilities are to be installed for filling road tankers and railcars with both propane and butane.

MOBILE DEMONSTRATION VAN. — The Startrite Engineering Company, Ltd., of Gads Hill, Gillingham, has acquired a demonstration van to display the "Startrite" range of power tools, such as bench and pillar drills, surface planers, saw benches, small universal woodworkers, disc sanders, spindle moulders and multi-speed bandsaws. In conjunction with tool dealers it is also intended to demonstrate machines direct to industry. The unit is wired throughout and equipped with a "wandering lead" for connection to mains supply.

PRESSURE JET OIL BURNER.—We have received a pamphlet from Prior Stokers, Ltd., of 1–3, Brandon Road, York Way, London, N.7, which gives the particulars of a pressure jet fully automatic burner for oil with a viscosity of 200 seconds Redwood at 100 deg. Fah. Two units are in production, namely, model SH.A, 200,000/440,000 B.Th.U. per hour, and model SH.B, 440,000/800,000 B.Th.U. per hour. The oil supply is pumped at a pressure between 100 lb to 140 lb per square inch into an electric immersion heater, where its temperature is raised to 170 deg. Fah, and the unit is fitted with intermittent ignition from a high-tension transformer and fully automatic oil burner controls.

CHEMICAL WORKS SAFETY CONFERENCE.—The Association of British Chemical Manufacturers has issued the programme of its conference on "Chemical Works Safety," which is to be held at Harrogate from Friday to Sunday, November 5th to 7th. The whole of Saturday, November 6th, will be occupied in visits to the Billingham and Wilton works of Imperial Chemical Industries, Ltd., to see safety devices and methods in operation. At the conference sessions, at the Hotel Majestic, Harrogate, the discussions will be based on these works inspections.

CHEMICAL AND PETROLEUM ENGINEERING EXHIBITION.—Arrangements have now been completed to hold for the first time in the United Kingdom a joint exhibition of chemical plant and petroleum equipment. This exhibition will be known as the Chemical and Petroleum Engineering Exhibition, and will take place in the Grand Hall, Olympia, London, in June, 1958. It will be organised by F. W. Bridges and Sons, Ltd., and sponsored jointly by the British Chemical Plant Manufacturers' Association and the Council of British Manufacturers of Petroleum Equipment.

SYMPOSIUM ON POWDER METALLURGY.—The Iron and Steel Institute and the Institute of Metals are arranging a symposium on "Powder Metallurgy." It is to be presented on Wednesday and Thursday, December 1st and 2nd, at the Hoare Memorial Hall, Church House, Westminster, S.W.1. The papers to be discussed are in four groups: manufacture, properties and testing of powders; principles and control of compacting and sintering; manufacture and properties of structural engineering components; powder metallurgy of high-melting-point materials.

NATIONAL DIPLOMA IN AGRICULTURAL ENGINEERING.—The examination board in agricultural engineering (which is appointed by the council of the Institution of British Agricultural Engineers) has published its report on the fourth examination for the National Diploma in Agricultural Engineering. The report says that thirty candidates were accepted for entry, of whom twenty-eight presented themselves for the examination in July. There were nineteen candidates who were awarded the diploma, four who failed in one subject and five who failed the entire examination.

MOBILE SHOWROOM.—We are informed by Kerry's (Great Britain), Ltd., Warton Road, London, E.15, that it now has a mobile showroom for demonstrating machine tools. In this vehicle each machine is individually wired so that by simply connecting to a three-phase mains supply an on-the-spot demonstration can be quickly arranged. The exhibits are arranged in two lines, running the length of the 30ft coach and with a centre gangway. The layout allows easy inspection of all working parts, and the machines being exhibited include hack sawing machines, a fly press, drills and lathes.

RETIREMENT OF MR. W. J. BARLOW.—To-day, Mr. W. J. Barlow retires from the position of composing room overseer at our printers, George Reveirs, Ltd., after fifty-four years' continuous and loyal service. Mr. Barlow, known more generally throughout the office and works as "Bob," joined the house of Reveirs in 1900, on the introduction of the late Mr. Vaughan Pendred, who was at that time editor-in-chief of this journal. After a short period as a messenger, he served an apprenticeship and has spent all the succeeding years of his career in the composing room of the printers of THE ENGINEER. The editorial and publishing staffs of this journal, and all others associated with its production, join in wishing Mr. Barlow many years of happy retirement.

IMPORTS OF OIL BURNING APPLIANCES.—The Board of Trade has been asked to recommend the making of an Order in Council requiring imported oil burning apparatus of the following descriptions to bear an indication of origin:—Paraffin pressure and non-pressure-operated heating, boiling, cooking and lighting appliances; independent burner units, and petrol and paraffin-operated brazing and blow lamps. This application has been referred to the standing committee appointed by the Board under the Merchandise Marks Act, 1926. Representatives of any interests substantially affected by the application who desire to be heard in opposition at the public inquiry, which will be held later by the committee, should write to the Secretary, Merchandise Marks Committee, Board of Trade, Horse Guards Avenue, Whitehall, London, S.W.1, as soon as possible and not later than November 12th.

OPERATIVES' COURSE IN NON-FERROUS METALS.—The British Non-Ferrous Metals Federation has produced an illustrated booklet entitled "Just the Job," which contains a quantity of useful information for those who may be deciding upon a career in the non-ferrous metals industry. The booklet also includes some particulars of a non-ferrous metals operatives' course, which has been designed by the City and Guilds of London Institute, and which will be available in the forthcoming session at a number of technical colleges throughout the country. It is a two-year practical course leading to a City and Guilds examination in which first and second class certificates will be awarded. The syllabus for the course—in the preparation of which the British Non-Ferrous Metals Federation has collaborated—covers the history and background of the non-ferrous industry and deals also with the plant and processes used in the manufacture and treatment of non-ferrous metals.

INTERNATIONAL MACHINE TOOL EXHIBITION, LONDON, 1956.—It is announced that the next International Machine Tool Exhibition to be organised by the Machine Tool Trades Association will be held in 1956 from June 15th to June 29th inclusive at Olympia, London. It will be the major machine tool exhibition of the year, as, following an understanding with the European Committee for the Co-operation of the Machine Tool Industries, no other international machine tool exhibition will be held in Europe during 1956. The following, in addition to the permanent staff of the M.T.T.A., form the committee responsible for organising the International Machine Tool Exhibition, London, 1956:—Mr. H. P. Potts (chairman), Mr. Robert W. Asquith, Mr. T. Bolton, Mr. W. Core, Mr. J. Frye, Mr. H. J. D. Kearns, Mr. J. G. Petter, Mr. J. F. Phillips, Mr. R. D. G. Ryder, Mr. J. G. Sagar, Mr. J. C. Snow, and the hon. treasurer of the Machine Tool Trades Association.

CONFERENCE ON PLASTIC TOOLING.—A conference on plastic tooling organised by the Sheet and Strip Metal Users' Technical Association is to be held on October 14th and 15th at the Institution of Electrical Engineers, Savoy Place, London, W.C.2. The papers to be presented at the conference include the following:—"Some Experiments on the Suitability of Plastics for Press Tool Manufacture," by Professor J. V. Connolly, Mr. P. K. Digby and Mr. W. J. Paul; "The Use of Plastic Press Tools for the Production of Motor Vehicle Panels," by Mr. W. B. Kidd; "Some Practical Aspects of the Manufacture of Forms from Plastics," by Mr. S. Matthews; "Modern Tools Made from Epoxy Resins," by Dr. K. Meyerhans; "Tooling with Phenolic Casting Resins for Sheet Metal Pressing," by Dr. F. L. Gilbert; "Glass Fibre Reinforced Plastics for Press Tools, Jigs and Patterns," by Mr. A. M. Dobson; "The Development of Plastic Tools with Particular Reference to the Use of Polyester Resins," by Mr. J. T. Maddison. Details of the conference and tickets can be obtained from the secretary of the Association at 49, Wellington Street, London, W.C.2.

Contracts

THE HEAD WRIGHTSON MACHINE COMPANY, Ltd., Middlesbrough, has received an order from Dorman, Long and Co., Ltd., for four large straightening presses which are valued at over £400,000. These presses are to be installed in the combined universal beam and heavy section mill which is to be erected at the Lackenby Works.

ALUMINIUM WIRE AND CABLE COMPANY, Ltd., is supplying 1600 miles of steel-cored aluminium conductor for the first stage of an extensive rural electrification scheme in Burma. This conductor will be erected by Crompton Engineering Company (Madras), Ltd., on the Pegu-Myingyan and Pegu-Allanmyo sections of a new 33kV grid system which will be fed by diesel power stations.

Personal and Business

MR. C. F. JACKSON has been appointed general manager of the Willesden works of Lancashire Dynamo and Crypto, Ltd.

MR. W. L. COLE, MR. D. BAYLISS and MR. W. A. MCLEOD have been appointed managing directors of Perry and Co. (Holdings), Ltd.

RICHARD COSTAIN, Ltd., states that, from October 4th its address will be 111, Westminster Bridge Road, London, S.E.1 (telephone, Waterloo 4977).

THE INSTITUTION OF ENGINEERING DESIGNERS has established its headquarters at 38, Portland Place, London, W.1 (telephone, Langham 8847).

MR. F. W. LAMPARD has been appointed northern manager of Silentbloc, Ltd., and the Andre Rubber Company, Ltd., at 11, Cloth Hall Street, Huddersfield.

COMPOFLEX, Ltd., 26, Grosvenor Gardens, London, S.W.1, states that it is opening a new advisory centre on flexible tubes for industry at Huddersfield Road, Oldham.

THE WATER POLLUTION RESEARCH LABORATORY (D.S.I.R.) is to move, on October 6th, to Elder Way, London Road, Stevenage, Herts (telephone, Stevenage 820).

THE NORTH-EASTERN MARINE ENGINEERING COMPANY (1938), Ltd., announces that Mr. Ernest Dale, a director and the works manager of the company, retired at the end of September.

INTERNATIONAL AERADIO, Ltd., 40, Park Street, London, W.1, and Adalia Ltd., Montreal, have made an agreement by which both companies will jointly offer consulting service to governments and industry.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., states that Mr. R. R. Whyte has taken over the control of its Germiston Works, Glasgow. He continues to serve also as superintendent of the small turbine department at Trafford Park, Manchester.

LLOYD'S REGISTER OF SHIPPING states that Mr. A. Urwin has retired from the position of a principal ship surveyor on the chief ship surveyor's staff at headquarters. He has completed thirty-five years' service with the society and became a principal surveyor in charge of plan approval in 1949. Mr. J. Irwin has succeeded Mr. Urwin as principal surveyor in charge of plan approval. Mr. H. J. Adams has been appointed principal ship surveyor for research, and Mr. D. Turner has become principal ship surveyor in charge of the ship reports department.

DORMAN, LONG AND CO., Ltd., Middlesbrough, states that, from tomorrow, three new wholly owned subsidiaries will take over its trading activities. They are: Dorman, Long (Bridge and Engineering), Ltd., which will deal with the activities at the bridge and constructional works, Middlesbrough, at the London constructional works, and at the bridge and contracting department at Luton; Dorman Long (Chemicals), Ltd., which will be responsible for the trading activities of coal by-products distillation carried on at Port Clarence, and Dorman Long (Steel), Ltd., which will take over all the direct trading activities of the parent company other than those referred to in the foregoing.

British Patent Specifications

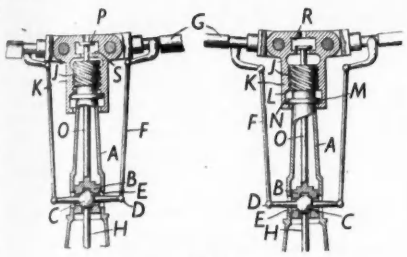
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

AERONAUTICAL ENGINEERING

715,094. March 26, 1952.—ROTATING WING AIRCRAFT, Saunders-Roe, Ltd., Osborne, East Cowes, Isle of Wight, and Kenneth Watson, of 17, Archery Road, Woolston, Southampton.

In rotating wing aircraft it is desirable to provide means for automatically setting the rotor blades, in the event of power failure, to an auto-rotative setting, with an angle of incidence such that the rotor will be maintained in auto-rotation. With a view to



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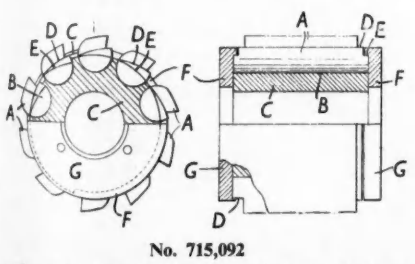
providing, in a rotor having collective and cyclic pitch control, automatic setting of the blades to an auto-rotative setting in the event of power failure, this invention proceeds on the basis of an automatic displacement of the rotor hub in response to a predetermined reduction in the torque supplied to the hub. As shown in the drawings, the rotor driving shaft *A* is a hollow vertical shaft containing a piston *B* on which is mounted, by a ball joint *C*, a control spider *D*. The arms of the spider project through slots *E* in the hollow shaft and are coupled by links *F* to the rotor blades *G*. Collective pitch control is applied under normal circumstances by raising or lowering the piston *B* and cyclic pitch control by rocking the spider *D* in relation to the piston. A rod *H* operated by the pilot imparts these adjustments to the spider. At the upper end of the shaft is a 45 deg. helix *J* with a left-hand thread engaging a corresponding thread in the rotor hub *K*. The shaft rotates clockwise as seen from above, when driven by the engine, and the torque then pulls the hub down in relation to the shaft to a position, defined by engagement of an abutment *L* on the hub with a collar *M* on the shaft. On release of the torque the lift pulls the hub *K* upwards in relation to the shaft *A* to a position, shown in the right-hand view, defined by engagement of another abutment *N* on the hub with the collar *M* on the shaft. In this position the blades *G* have an auto-rotative setting. The control spider *D* is the fixed datum reference from which hub displacement causes pitch change, upward movement of the hub *K* in relation to the spider *D* serving to reduce the blade pitch. A rod *O* extends from the piston *B*, through the upper end of the shaft, and carries at its upper end a flange *P* which coacts with stops *R* and *S* in the hub to limit the amount of collective pitch change available to the pilot.—*September* 8, 1954.

TOOLS AND WORKSHOP APPLIANCES

715,092. March 17, 1952.—MILLING CUTTERS OR HOBS, Hans Kruse, 15, Grabenstucken, Hamburg-Gr. Flottbeck, and Carl Fette, 4, Theresenweg, Hamburg-Nienstedten, Germany, trading as the firm of Wilhelm Fette.

As indicated in the drawing the cutter *A* on the left-hand side is shown in the circular grinding position and the right-hand cutters are shown in the relief position. They have a part-cylindrical section



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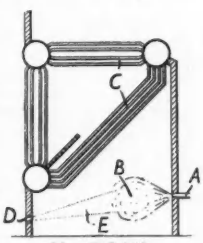
and rest in curved grooves *B* in the cutter body or carrier *C*. The parts of the cutters in engagement with the carrier amount to less than half the diameter of the part-circular section at the groove *B* and each comprise less than a half-circle in section. At both ends the cutters are provided with curved shoulders *D* and *E*, over which end caps *F* and *G* engage. The cap engages over the shoulders *D* and serves to retain the cutters in the circular grinding position while the caps *F* and *G* fit over the shoulders *E* of the cutters and serve to retain the cutters in the subsequent position, giving relief, that is, with the cutters turned so as to position the cutting edges furthest from the axis of rotation of the milling cutter, thus leaving a clearance surface behind the cutting edge.—*September* 8, 1954.

STEAM GENERATORS

715,218. February 14, 1952.—BOILER FURNACES, Charrington, Gardner, Locket and Co., Ltd., and Alexander Macfarlane Russell and John Terence Brownrigg Bookey, all of Tower House, 40, Trinity Square, London, E.C.3.

Trouble has been experienced in boiler furnaces fired with oil or with pulverised fuel due to the formation on the final heating surfaces of the boiler plant, particularly from air preheaters, of acid deposits arising from oxidation of the sulphur in the fuel to SO_3. The invention, with a view to reducing the tendency for the formation of acid deposits on the final heating surfaces of a boiler fired with oil or with pulverised fuel, provides for the discharge into the furnace of an auxiliary organic material, termed an inhibitor, under conditions such as will produce a cloud of carbon particles and thereby inhibit oxidation of sulphur in the fuel to SO_3. It is preferred to use as the inhibitor an auxiliary fuel of high aromatic content—for example, a liquid fuel derived from the distillation of coal tar, e.g. CTF 200, CTF 100, or CTF 50. The figures following the designation CTF indicate the temperature, in degrees Fahrenheit, at which the fuel is in a condition suitable for atomisation. As shown in the drawing, the boiler is provided with four main oil burners *A*. The oil supplied to each burner burns in a ball-shaped combustion zone *B* beneath the boiler tubes *C*. The inhibitor, which, as already explained, is preferably an auxiliary fuel of rich aromatic content, is supplied through a series of injectors *D* in the rear wall of the furnace, one opposite each burner *A*. The inhibitor passes from each injector into the combustion zone *B* in a concentrated jet *E*. The specification shows the application of the principle to several kinds of boilers.—*September* 8, 1954.



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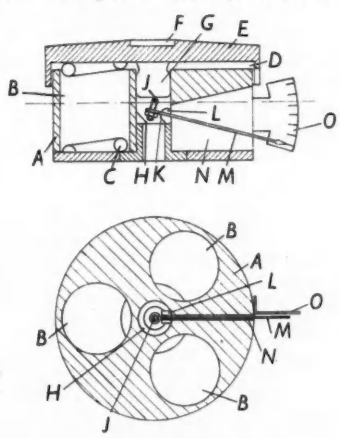
METALLURGY

715,081. January 30, 1952.—ROLLING OF METAL STRIPS AND SHEETS, Gerhard Wessendorf, 32, Hagenerstrasse, Hohenlimburg, Westphalia, Germany.

The invention relates to a device for the production of substantially constant pressure during the rolling of steel or iron or non-ferrous metal strips and sheets. Referring to the drawing, the device com-



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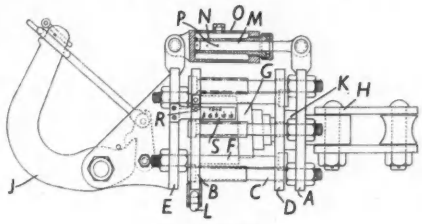
prises a cylindrical block *A* with apertures *B* accommodating compression springs *C*, which bear against a cover *E* over the block *A*, there being an appropriate space *D* between the block and the cover. The block rests with its base upon the roll bearing. For correct centring of the device there is provided a recess *F* in the cover *E* to receive the end of the pressure spindle. The cover has a peg *G* entering a central bore *H* in the block, and against the lower end of the peg presses an adjusting screw *J* in the short arm *K* of a lever which acts as an indicator and is pivotally supported in a bearing *L*. A long arm *M* of the indicator lever is guided in a vertical slot *N* in the block and moves over a scale *O*. The device is inserted and remains permanently in position between the pressure spindle and the bearing of one of the rolls of a mill. The springs resiliently transmit the pressure exerted by the pressure spindle to the bearing of the roll, and the indicator shows the operator whether or not the pressure is correctly adjusted.—*September* 8, 1954.

MARINE ENGINEERING

715,270. November 12, 1951.—TOW HOOKS FOR MARINE USE, Ferguson Brothers (Port Glasgow), Ltd., Newark Works, Port Glasgow. (*Inventor: Hugh Strathern.*)

From the drawing it will be seen that the members *A* and *B* are coupled by bars *C* passing through the member *D*. Members *D* and *E* are coupled by bars *F*, passing through the member *B*. *G* is a volute spring separating the members *B* and *D*, and *H* is a shackle connected to member *A*, while *J* is the slip hook, connected to *E*. A resilient pad *K* is interposed between



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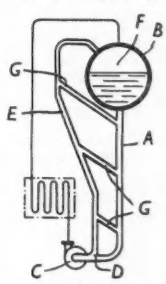
the members *A* and *D*, and *L* are supporting rollers to carry the weight of the tow hook. At the top of the drawing is a piston *M* coupled to the member *A* and sliding in a cylinder *N*, which is connected to the member *E*. The cylinder is arranged within a casing *O*, which constitutes a fluid reservoir. In the cylinder walls are holes *P*, each of the series being smaller in diameter towards the head of the cylinder. *R* is a pointer fastened to the member *B*, and *S* is a scale fastened to the member *E*, and marked in tons. In practice the load on the slip hook *J* causes the members *D* and *E* to move relatively to the members *A* and *B* which are connected to the shackle *H* and so to the towing bow on the tug, the load being transmitted between the relatively movable portions of the damping device by the spring *G*, which is stressed accordingly. Shocks in the towing cable are transmitted to and absorbed by the spring, so that changes of stress in the cable are less sudden. A modified design is also shown in the specification.—*September* 8, 1954.

STEAM GENERATORS

715,267. November 16, 1950.—NEUTRALISING THE FORMATION OF STEAM BUBBLES IN THE DOWNCOMER OR DOWNCOMERS OF FORCED CIRCULATION STEAM BOILERS, David Dalin, Stenkellen, Ronninge, Sweden.

Referring to the drawing, a forced circulation boiler is shown provided with a downcomer *A* depending from the drum *B* to the circulating pump *C*. From an opening *D* in the lowest part of the downcomer a steam evacuating pipe *E* leads to the steam space *F* of the drum, through which the steam bubbles formed are withdrawn. Connecting pipes *G* are also arranged between the downcomer and the steam evacuating pipe at the places where formation of steam bubbles may be expected, and at such points of connection the pipe *E* should be at least 35mm diameter in the case of a standard downcomer of approximately 15m length and 125mm diameter. In this instance the steam evacuating pipe is placed entirely outside the downcomer. Several modified arrangements to suit different kinds of steam boilers are shown in the specification.—*September* 8, 1954.



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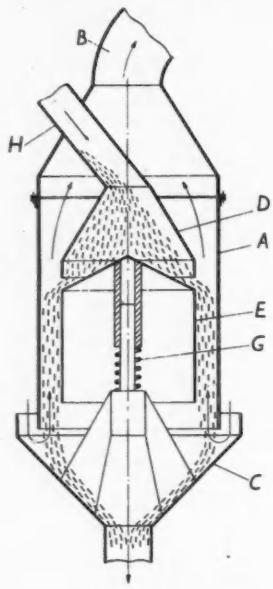
SIEVES AND SEPARATORS

715,176. July 16, 1952.—SEPARATING LOOSE MATERIAL SUCH AS GRAVEL, Miag Muehlenbae und Industrie G.m.b.H., Braunschweig, Germany.

The apparatus consists preferably of a hollow cylindrical container *A*, which may wholly or partly consist of transparent material. An air outlet *B* is arranged at the upper end; opposite the lower open end of the hollow container a receiving hopper *C* for the cleaned loose material is provided. The arrangement at the lower end is such that, as indicated by

the arrows, air is admitted from below for upward flow through the container *A*. The hopper has a lower outlet for discharge of the screened material. In the interior of the container are provided the receiver container *D* and distributing member *E* with a conical distributing surface. The receiver container is arranged above the member *E* to form a circular aperture to allow the escape of the



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loose material in a fine stream. In the construction shown the member *E* adjusts itself in height automatically according to the load of material supported through spring *G* and varies the aperture between itself and the receiver container *D*. The receiver container is fitted with the inlet *H* for the loose material. Modified designs of such separators are also shown in the specification.—*September* 8, 1954.

Launches and Trial Trips

HANSTELLUM, oil tanker ; built by Hawthorn Leslie (Shipbuilders), Ltd., for Shell Bermuda (Overseas), Ltd.; length overall 557ft, breadth moulded 69ft 3in, depth moulded 39ft, deadweight 18,000 tons ; thirty-three separate cargo oil tanks, one cargo oil pump room, four turbine-driven cargo pumps, steam deck machinery, pressure ventilation system ; one set of double reduction geared turbines by Hawthorn Leslie (Engineers), Ltd., two cylinders, 8250 s.h.p.; steam supplied at 500 lb per square inch and 800 deg. Fah. by two Foster-Wheeler "D" pattern boilers, two 550kW turbine-driven alternators and one 200kW diesel-driven alternator. Trials, September 7th and 8th.

STAHOLM, cargo ship ; built at the Wallsend Shipyard of Swan, Hunter and Wigham Richardson, Ltd., for A/S Hartank and A/S Har, Oslo ; length between perpendiculars 430ft, breadth moulded 60ft 6in, depth moulded to upper deck 38ft 9in, deadweight 9000 tons on 25ft 6in draught, cargo capacity 504,756 cubic feet bale, service speed 14½ knots ; four passengers ; five holds, 3-ton and 5-ton derricks and one 25-ton derrick, electric deck machinery ; Wallsend-Doxford two-stroke oil engine, five cylinders, 670mm diameter by 2320mm combined stroke, 5000 b.h.p. at 108 r.p.m., three 175kW diesel-driven generators. Trial, September 15th.

IRMA, cargo liner ; built by Alexander Stephen and Sons, Ltd., for Det Bergenske Dampskibsselskab, Bergen ; length 400ft, breadth 57ft, depth 35ft, load draught 23ft, deadweight 6530 tons, gross tonnage 4550 ; twelve passengers ; five cargo holds, electric deck machinery, derrick complement includes 3-ton, 5-ton and 10-ton derricks and a 30-ton heavy derrick ; three 180kW diesel-driven generators ; Stephen-Doxford two-cycle oil engine, four cylinders 670mm diameter by 2320mm combined stroke. Launch, September 18th.

Catalogues

SAUNDERS VALVE COMPANY, Ltd., Cwmbran, Newport.—Saunders Technical Handbook.

THE LEWIS SPRING COMPANY, Ltd., Resilient Works, Queen Street, Redditch.—Book on spring design.

DAWE INSTRUMENTS, Ltd., 99, Uxbridge Road, London, W.5.—Booklet entitled "Dawe Instruments in Industry."

TRETOL, Ltd., 12–14, North End Road, London, N.W.11.—Leaflet describing Tretol Chemiprufe enamel M.90.

GEORGE COHEN SONS AND CO., Ltd., Broadway Chambers, Hammersmith, W.6.—Second edition of the "600" machinery catalogue.

ELLIOTT BROTHERS (LONDON), Ltd., Century Works, Lewisham, S.E.13.—Folder describing Elliott instruments which are being exhibited at the Philadelphia Exposition.

A REYROLLE AND CO., Ltd., Hebburn, Co. Durham.—Publication 10MS No. 420, describing installation, recommendations and spares for 132kV rotary isolators and earthing switches.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

DIESEL ENGINE USERS ASSOCIATION

Thurs., Oct. 21st.—Caxton Hall, Westminster, London, S.W.1, Presidential Address, "Modern Diesel Tugs," F. J. Mayor, 2.30 p.m.

HULL CHEMICAL ENGINEERING SOCIETY

Tues., Oct. 12th.—Hull Church Institute, Hull, "The Functions of the School Health Service," A. M. R. Cann, 7.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Oct. 4th.—LEEDS CENTRE : Yorkshire Electricity Board, Ferensway, Hull, "Modelling with Light and Colour," J. W. Howell, 7.30 p.m.

Wed., Oct. 6th.—EDINBURGH CENTRE : Manor Club, 12 Rothesay Place, Edinburgh, 3, "Home Lighting," A. H. Young and C. J. Missel-Brook, 7 p.m.——NEWCASTLE CENTRE : Liberal Club, Pilgrim Street, Newcastle, Chairman's Address, T. E. Dellow, 6.15 p.m.——SWANSEA GROUP : S. Wales Electricity Board's Demonstration Theatre, The Kingsway, Swansea, Chairman's Address, A. V. Sinclair, 6.30 p.m.

Thurs., Oct. 7th.—GLASGOW CENTRE : Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2, "Home Lighting," A. H. Young and C. J. Misselbrook, 7.30 p.m.——NOTTINGHAM CENTRE : Technical College, Nottingham, Chairman's Address, "The Lighting Engineer Gets Down to Earth," A. Roberts, 6 p.m.

INCORPORATED PLANT ENGINEERS

Tues., Oct. 5th.—EDINBURGH BRANCH : 25, Charlotte Square, Edinburgh, "Trends in Industrial Instrumentation," A. B. Dryburgh, 7 p.m.——LONDON BRANCH : Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, "Controlled Air Conditions in Factories," D. J. Hyam, 7 p.m.

Wed., Oct. 6th.—SOUTHAMPTON BRANCH : Polygon Hotel, Southampton, "The Control of Maximum Demand and Power Factor," A. W. Ingram, 7.30 p.m.

Thurs., Oct. 7th.—PETERBOROUGH BRANCH : Dujon Cafe, Market Place, Peterborough, "Plant Maintenance and Productivity," R. A. Rogers, 7.30 p.m.

Mon., Oct. 11th.—DUNDEE BRANCH: Mathers Hotel, Dundee, Film, "Materials Handling," 7.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Sat., Oct. 2nd.—LANCASHIRE BRANCH : Engineers' Club, Albert Square, Manchester, "Semi-Continuous Casting of Bronze," E. C. Elwood, 2.30 p.m.——WALES AND MON. BRANCH : Engineers' Club, Cardiff, "Some Aspects of Shell Moulding Technique," D. F. Bailey, 6 p.m.

Mon., Oct. 4th.—SHEFFIELD BRANCH : Sheffield and Eccleshall Co-operative Society Restaurant, Sheffield, Presidential Address, "Science Hand-in-Hand with Labour," E. Ayres, 7.15 p.m.

Tues., Oct. 5th.—SLOUGH SECTION : High Duty Alloys, Ltd., Slough, Film and Paper, "Aluminium Pattern Equipment," D. H. Potts, 7.30 p.m.

INSTITUTE OF FUEL

Wed. and Thurs., Oct. 6th and 7th.—Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, Conference on a Special Study of Sulphur Removal and Recovery from Fuels, 10 a.m.

Thurs., Oct. 14th.—Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, "Heat Transfer in a Continuous Reheating Furnace," R. J. Sarjant and D. Smith ; "The Significance of Sectional Heat Balances and Burner Performances in Furnaces," N. P. Bacon and R. J. Sarjant, 5.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., Oct. 12th.—85, Minories, London, E.C.3, "Some Fuel Injection Problems," W. P. Mansfield, 5.30 p.m.

INSTITUTE OF METALS

Tues., Oct. 5th.—OXFORD LOCAL SECTION : Cadena Cafe, Cornmarket Street, Oxford, "Diffusion in Metals," A. D. Le Claire, 7 p.m.

Tues., Oct. 7th.—LONDON LOCAL SECTION : 4, Grosvenor Gardens, London, S.W.1, Chairman's Address, "Some Men of Metallurgy," 6.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., Oct. 4th.—SCOTTISH CENTRE : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "The Design of Automotive Piston and Ring Assemblies," L. Howell, 7.30 p.m.

Tues., Oct. 5th.—N.W. CENTRE : Victoria and Station Hotel, Preston, "Post-War Development in Brake Linings," P. Tonge and M. Healey, 7.30 p.m.

Wed., Oct. 6th.—EASTERN CENTRE : Lion Hotel, Cambridge, "Heavy Duty Batteries for Commercial and P.S. Vehicles," C. P. Lockton, 7 p.m.

Thurs., Oct. 7th.—E. MIDLANDS CENTRE : Mechanics' Institute, Nottingham, "Paint-Synthetic Resin Finishes and Wet-on-Wet Spraying," C. Butler, 7.30 p.m.——LONDON CENTRE : Royal Society of Arts, John Adam Street, London, W.C.2, Ninth Annual General Meeting, Films, 6.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Wed., Oct. 6th.—S. WALES CENTRE : GRADUATES AND STUDENTS' SECTION : University College of S. Wales and Monmouthshire, Cathays Park, Cardiff, "Use of Glass in the Chemical Industry," C. E. McEwen, 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Oct. 4th.—N.E. RADIO AND MEASUREMENTS GROUP : King's College, Newcastle upon Tyne, Chairman's Address, D. H. Thomas, 6.15 p.m.——S. MIDLAND CENTRE : James Watt Memorial Institute, Great Charles Street, Birmingham, Annual General Meeting and Conversazione, Chairman's Address, A. R. Blandford, 6 p.m.——N. STAFFORDSHIRE SUB-CENTRE : Technical College, Stafford, Chairman's Address, J. M. Ferguson, 7 p.m.——Wig and Gown Hotel, Maidstone, "Fuel Supplies of the Future," D. Hicks, 7.30 p.m.

Tues., Oct. 5th.—N. MIDLAND CENTRE : British Electricity Authority, 1, Whitehall Road, Leeds, Chairman's Address, W. A. Crocker, 6.30 p.m.——N.W. CENTRE : Engineers' Club, Albert Square, Manchester, Chairman's Address, E. Bradshaw, 6.30 p.m.——S.E. SCOTLAND SUB-CENTRE : Carlton Hotel, North Bridge, Edinburgh, Chairman's Address, E. O. Taylor, 7 p.m.——RUGBY SUB-CENTRE : College of Technology and Arts, Rugby, Chairman's Address, D. Edmundson, 6.30 p.m.

Wed., Oct. 6th.—TEES-SIDE SUB-CENTRE : Cleveland Scientific and Technical Institution, Middlesbrough, Chairman's Address, E. J. Grubb, 6.30 p.m.——S.W. SCOTLAND SUB-CENTRE : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Chairman's Address, 7 p.m.——SOUTHERN CENTRE : College of Technology, Portsmouth, Chairman's Address, E. A. Logan, 6.30 p.m.

Thurs., Oct. 7th.—ORDINARY MEETING : Savoy Place, London, W.C.2, Inaugural Address as President, J. Eccles, 5.30 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Mon., Oct. 4th.—N.E. BRANCH : Northern Architectural Association Hall, 6, Higham Place, Newcastle upon Tyne, "Engineering Costing and Estimating," W. S. Shield, 7.15 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Oct. 5th.—39, Elmbank Crescent, Glasgow, Presidential Address, A. M. Robb, 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Tues., Oct. 5th.—AUTOMOBILE DIVISION : 1, Birdcage Walk, Westminster, London, S.W.1, Annual General Meeting, Address by the Chairman of the Division, 5.30 p.m.——S. WALES BRANCH : Mackworth Hotel, Swansea, Address by the Chairman, L. J. Kastner, 6 p.m.

Wed., Oct. 6th.—SOUTHERN BRANCH : Technical College, Brighton, "Patents for Inventions," R. E. Tree, 7 p.m.

Thurs., Oct. 7th.—N.W. BRANCH : Engineers' Club, Albert Square, Manchester, "Practical Training in Industry for the Graduate in Mechanical Engineering," Part I, Kenneth R. Evans ; Part II, H. W. Fulton ; Part III, R. S. Medlock and D. P. Lant ; Part IV, J. A. Pope, 6.45 p.m.——SCOTTISH BRANCH : Royal Technical College, Glasgow, "Nuclear Reactors and Power Production," Sir Christopher Hinton, 7.30 p.m.——YORKSHIRE BRANCH : Visit to the Royal Ordnance Factory, Barnbow, Leeds ; "The Impact of Development and Research on Production and Design," L. H. Leedham, 2.30 p.m.

Fri., Oct. 8th.—SCOTTISH BRANCH : North British Station Hotel, Edinburgh, "Nuclear Reactors and Power Production," Sir Christopher Hinton, 6.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Oct. 4th.—HALIFAX SECTION : George Hotel, Huddersfield, "Industrial Uses of 'Terylene' Polyester Fibre," D. N. Marvin, 7.15 p.m.——WESTERN GRADUATE SECTION : Grand Hotel, Bristol, "Work Study," G. R. Burn, 7.30 p.m.

Tues., Oct. 5th.—MANCHESTER GRADUATE SECTION : College of Technology, Sackville Street, Manchester, 1, "Rust, its Prevention and Removal," F. S. Bricknell, 7.15 p.m.——PETERBOROUGH SECTION : Campbell Hotel, Bridge Street, Peterborough, "Production of Domestic Appliances," H. F. Adams, 7.30 p.m.

Wed., Oct. 6th.—NOTTINGHAM SECTION : Victoria Station Hotel, Milton Street, Nottingham, "Impressions of Production Methods in U.S.A.," 7 p.m.

Thurs., Oct. 7th.—PETERBOROUGH SECTION : The Dujon Ballroom, Peterborough, "Plant Maintenance and Productivity," R. A. Rogers, 7.15 p.m.——READING SECTION : Great Western Hotel, Reading, "The Influence of the Production Engineer on Productivity," J. V. Connolly, 7.30 p.m.——SOUTHERN SECTION : Polygon Hotel, Southampton, "Surface Finish," J. Halling, 7.15 p.m.

Fri., Oct. 8th.—N.E. GRADUATE SECTION : Roadway House, 80, Oxford Street, Newcastle upon Tyne, "Nickel Plating and Metal Finishing," L. F. Prior, 7 p.m.

INSTITUTION OF SANITARY ENGINEERS

Thurs., Oct. 14th.—Caxton Hall, Caxton Street, Westminster, London, S.W.1, "Some Aspects of Administrative and Establishment Work in the Engineer's Department of a Large Municipal Authority," J. F. Lyne, 6 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Tues., Oct. 5th.—N. IRELAND BRANCH : College of Technology, Belfast, "Concrete as an Engineering Material," J. Singleton-Green, 6.45 p.m.

Thurs., Oct. 7th.—11, Upper Belgrave Street, London, S.W.1, Presidential Address, S. B. Hamilton, 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Oct. 1st.—Pepys House, 14, Rochester Row, London, S.W.1, Film Evening, "Prestressed Concrete Methods," introduced by C. E. Reynolds, 7 p.m.

Fri., Oct. 8th.—ORDINARY MEETING : Pepys House, 14, Rochester Row, London, S.W.1, "Oxygen Breathing Apparatus with Special Reference to Everest, 1953," P. W. Fitt, 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

To-day, Oct. 1st.—Engineers' Club, Albert Square, Manchester, Inaugural Address by the President, S. N. Clift, 6.30 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY

Thurs., Oct. 7th.—Mining and Technical College, Library Street, Wigan, Annual General Meeting, 3.15 p.m.

NATIONAL TECHNICAL GROUP, ELECTRICAL POWER ENGINEERS' ASSOCIATION

Mon., Oct. 4th.—LONDON LOCAL GROUP : York Room, Caxton Hall, Caxton Street, Westminster, London, S.W.1, "Modern Generating Plant Problems," C. C. Hitchen, 7 p.m.

NEWCOMEN SOCIETY

Wed., Oct. 13th.—Science Museum, Exhibition Road, South Kensington, London, S.W.7, "New Light on Ancient Turret Clocks," R. P. Howgrave-Graham, 5.30 p.m.

NORTH-WESTERN FUEL LUNCHEON CLUB

Wed., Oct. 6th.—OPENING MEETING : Engineers' Club, Albert Square, Manchester, "King Cotton and King Coal," W. T. Winterbottom, 1.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., Oct. 5th.—MIDLAND COUNTIES BRANCH : Birmingham and Midland Institute, Paradise Street, Birmingham, Inauguration of Branch, by the President, C. H. S. Howkins, Films, 6 p.m.

Tues., Oct. 12th.—SCOTTISH BRANCH : North British Hotel, Edinburgh, Inauguration of Branch by the President, C. H. S. Howkins, 6.30 p.m.

ROYAL AERONAUTICAL SOCIETY

Tues., Oct. 12th.—SECTION LECTURE : 4, Hamilton Place, London, W.1, "Behaviour of Light Alloys at Elevated Temperatures," B. C. Gadd, 7 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Wed., Oct. 6th.—CORROSION GROUP AND THE MICROBIOLOGY GROUP : Burlington House, Piccadilly, London, W.1, "The Influence of Micro-Organisms on the Corrosion of Metals," F. Wormwell and T. W. Farrer, 6.30 p.m.

SOCIETY OF ENGINEERS

Mon., Oct. 4th.—Geological Society, Burlington House, Piccadilly, London, W.1, "The Influence of Murdoch on the Modern World," Marjorie Lovell Burgess, 5.30 p.m.

SOCIETY OF INDUSTRIAL ENGINEERS

Thurs. to Sat., Oct. 7th to 9th.—Conference on Work Study and Productivity, Prince of Wales Hotel, Southport.

SOCIETY FOR WATER TREATMENT AND EXAMINATION

Thurs. to Sat., Oct. 7th to 9th.—Autumn Meeting at Bournemouth.

WOMEN'S ENGINEERING SOCIETY

Fri. to Sun., Oct. 8th to 10th.—MANCHESTER BRANCH: Annual Conference in Birmingham.